Supporting Knowledge Creation in Design-Led Multidisciplinary Education

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Thank you all.

DECLARATION

I declare that no outputs submitted for this degree have been submitted for a research degree of any other institution.

Mark Bailey

1st March, 2021

ABSTRACT

The case for this PhD by published works is based on reflection on a 32-year career in design practice and higher education. In particular it focuses on the analysis of 12 years of action research in design-led multidisciplinary innovation education that employs an iterative, enquiry-based, constructivist, group-learning pedagogy.

Contemporary design is operating in an 'expanded field', working across public, private and third sectors to address increasingly complex, networked and rapidly-evolving situations which call for a multidisciplinary approach. In such contexts individuals able to use design to facilitate knowledge-creation within diverse multidisciplinary, multi-stakeholder groups have a particularly valuable role to play.

This study is built on the premise that the act of designing represents a creative, constructive synthesis of knowledge drawn from different disciplines. Design, in this case, is positioned as a facilitatory practice, conceptualised by the author as Co-Speculative Knowledge Venturing (C-SKV), which offers a means of bringing a diverse multiplicity of knowledge, expertise and experience to bear in pursuit of opportunities within a given situation. Such synthesis by design provides a knowledge platform for innovation.

The contents and meaning of the publications upon which this claim for PhD by Published Works is based have been analysed as a data source in light of existing theories of design, innovation and pedagogy and with reference to the author's own tacit knowledge. The author has then used an iterative, reflective, Research Through Design methodology to synthesise his findings in order to establish a supporting framework for design-led multidisciplinary innovation education.

Within the educational context of the study the author identifies that C-SKV allows new combinations of knowledge, within a given situation, to be explored and thereby new knowledge to be created within three domains: knowledge for, and of, the project situation; knowledge about practices, methods and tools for designing; and knowledge of self.

The author proposes that, in pursuit of such knowledge-creation, students experience significant, and repeated, periods of uncertainty in a liminal learning state. His primary contribution is a framework, described as a Liminal Learning Lab, which provides a 'safe environment' to support multidisciplinary learning by engagement with these three domains of knowledge-creation supported by three pillars; Actions, Attitudes and Actors.

This framework is now supporting developments in multidisciplinary education here and overseas and has value for those seeking to develop such education and for organisations seeking to establish a multidisciplinary learning culture. It provides a platform for further research into liminality in knowledge-creation within such multidisciplinary social learning settings.

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1.0 INTRODUCTION

1.1 Background

This commentary draws on research published over the past decade but informed by the author's 32-year career in design practice and design higher education. Indeed, the author's early experience of trying to define design has had a significant impact on the way that he has thought about, practised and taught design over the course of that career.

Asked to define design at an interview for his undergraduate degree in 1984, the author's spontaneous response was "Design is the art of creative compromise". At the time he didn't really know quite what he meant by this statement. However, his subsequent career has provided him with significant opportunity to reflect upon and refine his thinking in this regard.

On graduating, he embarked on a career in the aerospace industry working as the sole Industrial Designer in a company dominated by 30,000 engineers. His 8-years of experience in this industry, followed by a period managing design in a general product and transportation design consultancy, provided numerous opportunities for him to reflect on that concept of design as 'the art of creative compromise' and for his position around this to consolidate. What he saw was that multiple sources of knowledge and expertise contribute to the creation of any new design and that the designer has to balance these against the various criteria by which the outcome will be judged and artfully arrange them in a creative and appealing manner. His was a view, which he later discovered was supported by Buchannan (1992, p.15): "*Problem solution* is a *synthetic* sequence in which the various requirements are combined and balanced against each other..."

Moving from design professional practice to teaching industrial design at Northumbria University in 1998, the author brought this understanding to his academic practice. By engaging students with external partner organisations to learn through tackling 'real-world problems' [1] [1], an aspect of 'authentic learning' (Donovan, Bransford, and Pellegrino, 1999), he maintained a commercial currency to his knowledge. Through establishing partnerships with multiple commercial, social and civic enterprises, across diverse sectors, he was able to test with many organisations his emerging understanding of the potential for design as a facilitator of multidisciplinary practice.

1.2 Context

In 2005, Sir George Cox, chair of the UK Design Council, was commissioned by former Prime Minister, Gordon Brown, at that time Chancellor of the Exchequer, to explore the role of the creative industries in driving UK productivity and economic growth. Amongst a number of recommendations drawn from this review of international best practice in creativity/business integration, was a proposal to establish centres of excellence 'combining creativity, technology and business teaching' in multidisciplinary education that would educate generations of future leaders in the benefits and skills of working across disciplines in pursuit of innovation (Cox, 2005, p.33). The review spawned a number of HEFCE-funded initiatives to address this challenge. At Northumbria University, the author, supported by senior colleagues, led a £65,000 HEFCE strategic fund pilot study, which demonstrated the potential of design practice to facilitate multidisciplinary innovation. Based on the findings of this pilot, the author was instrumental in the design, validation and launch of a Master's degree initially entitled

[1] Note: hereafter square bracketed numbers in text, figures and tables refer to publications 1- 7 cited in the Prima Facie Case for this submission and presented in Appendices 1 and 2

MA/MSc Multidisciplinary Design Innovation, which commenced in 2008 and which he led. (Subsequently the programme has been renamed MA/MSc Multidisciplinary Innovation (MDI)). Initially focused, as Cox advocated, on the three disciplinary domains of design, business and technology the programme has, over-time, evolved to rely more heavily on the influence of design and business teaching whilst simultaneously drawing students from a much wider disciplinary mix [1 & 7].

The author established a community of integrated academic practice [3] around MDI and, aside from educating over 200 students to-date, this community has been responsible for knowledge exchange with more than 70 organisations, generated over £1.1million in research council grant and contract research income and collectively members of the community have produced some 40 academic publications. The author has an Impact Case Study[2] submitted for REF2021 underpinned by this group's research.

In 2010 the author contributed to a HEFCE/NESTA-funded report; 'Multi-disciplinary Education in the UK – recommendations for HEIs and Government', prepared by the UK Design Council (Design Council, 2010). This highlighted early endeavours of a number of UK universities responding to the challenge laid down by Cox. The report painted a positive picture and only hinted at the institutional challenges that pioneers of multidisciplinary education faced as,

> it takes time to build relationships between colleagues and institutions, to appoint staff with the appropriate skills and experience to teach these courses, to test, iterate and refine new methods of teaching and new administrative models (Design Council, 2010 p. 31).

Indeed, a decade after that report was published, many of the programmes on which it reported have disappeared or morphed into other entities and one of the primary reasons for this is not a lack of validity or demand, but the entrenched positions, administrative structures and financial models that promote mono-disciplinary research, publication and academic career advancement in UK academe and elsewhere. Only in more recent years has there been any noticeable shift towards multidisciplinarity in research funding calls. The body of knowledge explored in this commentary has been established against this, often challenging, institutional backdrop. However, notwithstanding challenges to multidisciplinary education evident in UK academia, the author's work has been influential in establishing multidisciplinary education overseas. In 2012 he was an advisor to The Hong Kong Polytechnic University as they established their MDes International Design and Business Management programme. More recently he was invited by the British Council to develop and lead Enterprise Education Policy Dialogue workshops in Armenia based on his design-led multidisciplinary innovation education approach. Subsequently, he was asked to write Enterprise Education Policy Recommendations for the Director of The Commission of International Relations and the Prime Minister of the Republic of Armenia where he is now piloting a new Design-led Entrepreneurial Innovation programme in partnership with the American University of Armenia's Open Education programme together with the senior advisor to the Prime Minister and the High Commissioner for Diaspora Affairs.

[2] ICS 'Transforming organisational practices and achieving long-term change through design-led innovation' Bailey, M. and Spencer, N. approved for submission to UoA 32, REF2021. This demonstrates impact of design-led multidisciplinary approach across different sectoral and organisational settings referencing impact with Unilever and Gatsby Charitable Foundation

1.3 Pedagogic orientation

MDI is founded on a constructivist approach which borrows from cooperative, collaborative and problem-based pedagogies (Johnson and Johnson, 1994; Bruffee, 1995; Davidson and Major, 2014). It draws on signature pedagogies (Shulman, 2005) of design (Shreeve, 2015) specifically 'The Studio'; 'Projects and Briefs'; 'Materiality'; 'Dialogue' and 'The Crit'. It is also informed by signature pedagogies of business leadership studies which favour discursive, dialogic, project-based and reflective approaches (Jenkins, 2012). Further, it is influenced by entrepreneurship and enterprise education which supports development of entrepreneurial agency (Jones, 2018), akin to self-efficacy (Bandura and Jourdan, 1991) through a combination of pedagogic (educator-directed), andragogic (student self-directed) and heutagogy (student-negotiated) approaches (Jones et al. 2019).

The philosophies of John Dewey, who 'believed that learning should be active and collaborative where students drive their own discovery' (Fink and Inkelas, 2015, p.6) lay the foundations for the theory of communities of practice (Lave and Wenger, 1991). These are collaborative learning environments in which practitioners 'develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems – in short a shared practice' (Wenger, 2015, p.2). Schön (1987, p.37) describes a practicum as 'a setting designed for the task of learning a practice' that is 'a virtual world, relatively free of the pressures, distractions and risks of the real one'. Such a 'safe environment' [1], akin to Carl Rogers' student-centred ideal classroom environment described as 'emotionally warm, supportive environments in which [teachers] worked collaboratively with their students to achieve mutual goals' (Centre for the Use of Research and Evidence in Education, 2018) is established as the fundamental learning environment of MDI. The safety offered by this environment, supports transformative learning (Mezirow, 1991) in which students learn collaboratively through critically reflective discourse transforming their individual and collective assumptions and frames of reference in any given project situation and in their professional development.

1.4 Body of knowledge

As a body of knowledge through which to explicate the practice of MDI and its community the author has selected seven double-blind, peer-reviewed international publications (Appendices 1 and 2) from a body of work that he has authored and co-authored comprising over 30 such publications and multiple professional reports, research and practice dissemination films etc. These publications are presented in chronological order which demonstrates the iterative build of planning, action, analysis and reflection over an extended period. This has allowed the development of the refined interpretation presented as the contribution to knowledge. Participatory action research underpins much of the work represented within this collection and such research is characterised by iterative, social construction of knowledge. It is, therefore, unsurprising that the publications presented within this study are all jointly-authored and from a constructivist standpoint. For this reason, it is important that the author, in preparing this commentary, has gone beyond simply reporting on the body of knowledge and its contribution in the field, but has used a Research Through Design approach (Frayling, 1993) as a means to develop refined understanding, meaning and value from the work.

In their MDI studies, multidisciplinary teams of students learn through undertaking projects conducted with external partner organisations, working with diverse stakeholders to address innovation challenges that matter to those organisations. These projects, the Master's programme within which they are undertaken and the circumstances of the partnering organisations, form the research site for the published works.

2.0 POSITION

When Voltaire, stated “Le doute n’est pas une état bien agréable, mais l’assurance est un état ridicule” (uncertainty is an uncomfortable state, but certainty is ridiculous), he unwittingly summed up the natural state of the designer; dissatisfied with the status quo and continually striving for improvement whilst simultaneously aware that when they reach the ‘certainty’ of an improved position, the uncertainty and questioning will begin again. Designers, therefore, spend a lot of time being uncomfortable! Inherent in the designer’s pursuit of improvement is a lot of time spent dealing with the ambiguity and liminality of unresolved, uncertain and incomplete knowledge. In anthropology, liminality refers to the ambiguous state in ‘rites of passage’ through which an individual passes as they transition from one state to another; a situation in which they have cast-off one identity but, as yet, not assumed another (Van Gennep, 1960; Turner, 1967). In their pursuit of improved states, designers adopt a constructivist epistemology, building and re-building alternative realities and continually interpreting the world around them whilst learning from their endeavours to make sense of it. In so doing they regularly encounter a form of liminality. In line with Fosnot’s, (1996, p.ix) conception that knowledge is "temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated" designers view knowledge constructed through design as temporary and developmental. The author also aligns with Vygotsky’s (1978) concepts of social constructivism in which a culture of social interaction underpins construction of knowledge.

Through repetition, designers learn to be comfortable with, or at least tolerate, ambiguity and they develop a creative confidence (Kelley and Kelley, 2013) that allows them to venture into previously unseen situations ready to create new knowledge, understanding and meaning in them. However, designers do not possess all of the knowledge and skills required to address the increasingly complex, ill-defined and dynamic situations, dubbed ‘wicked problems’ (Rittel & Webber, 1973; Buchannan, 1992), of contemporary life.

2.1 Design as Creative Compromise

Designing gives form (Alexander, 1971) and meaning (Verganti, 2009) to a design. Whatever form the designed output takes, it is a manifestation of synthesised knowledge crystallised as a version of certainty at the moment of its completion. Furthermore, that synthesised knowledge is a crystallisation of the multiple compromises, creatively made in the artistry of reaching that temporal certainty.

To illustrate this, consider the design of a pen. It is easy to recognise the multiple disciplinary contributions required to ensure that the pen is a suitable size and weight to hold; that the ink runs smoothly without leaking or drying-up; that it complies with all relevant legislation; that it is aesthetically appealing; that it can be manufactured in suitable numbers and at a suitable price for its intended market; etc. The relative weighting placed on each of these criteria has a manifest impact on the outcome of designing. This is why both the Mont Blanc Meisterstück and BIC Cristal can be so very different and yet both seen as class-leading pens delivering essentially the same affordance to the user, the wherewithal to write, whilst simultaneously conveying different meanings. The Author presents a detailed case-study of his own practice of such creative design-compromise in Appendix 3.

By virtue of the fact that the majority of designs offer new solutions to existing problems, or present new solutions to newly defined problems, the author suggests that the compromises crystallised in the brief moments of certainty, known as designs, can be viewed as new

knowledge created at the intersection of the various disciplinary boundaries where they are formed.

The range and diversity of stakeholder voices, and their requirements, increases as design has influence in an expanded field of integrated products, services, systems, and policies or strategies for governments and businesses. Consequently, in these settings the compromises between the various criteria are often informed by knowledge coming from widely diverse disciplines other than design. Through his academic career, and with his students and colleagues, the author has worked in such an expanded field and he has come to understand how increasingly diverse the influential voices are in any design situation.

Within this expanding field, relevant stakeholders who have valuable contributions to make may not be so comfortable or familiar with the ambiguity inherent in research, design and development cycles, and yet they can be a source of critical insights and criteria that must be addressed in the creative compromise of design. Design can offer facilitating approaches in mediating stakeholder involvement to establish creative compromise. The author's model of Co-Speculative Knowledge Venturing (C-SKV) offers such an approach within the educational setting.

3.0 METHODOLOGY

The Methodological approach is presented in three distinct sections:

3.1 The methodologies employed in the publications

3.2 The methodology employed in undertaking this study and preparation of this commentary

3.3 The philosophical research stance of the author

3.1 Methodologies employed in the publications

Each of the publications employs mixed methods in different combinations (Table 1). These methods sit within a broad action research approach (action, evaluation, reflection), which has been adopted across the suite of publications in which generative methods and tools of design practice form the action.

		Action			Evaluation			Reflection		
Publication		Generative workshop	Dynamic prototyping	Pattern identification	Case-study analysis	Survey	Semi-structured interviews	Reflection on Practice	Reflection in practice	Reflection on reflection in practice
1	'Safe Environments for Innovation-Developing a New Multidisciplinary Masters Programme'				■			■		
2	'New Design is Bigger and Harder-Design Mastery in a Changing World'						■	■		
3	'Making it Work; Integrated Academic Practice'	■				■	■	■		
4	'Framing Strategic Value through Design-led Innovation Practice'			■	■			■		
5	'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?'		■					■	■	■
6	'A design-led approach to transforming wicked problems into design situations and opportunities'	■		■			■	■		
7	'The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum'	■			■			■		

Table 1. Publication research method mapping

Greenwood and Levin (2007) present Action Research, not as employing a methodology, but as research strategy made up of Techniques, Work Forms and Research Strategy involving Insiders (problem owners, stakeholders in a situation under exploration) and Outsiders (the researchers). They describe a co-generative model comprising essentially two distinct phases: clarification of the research question and 'initiation and continuation of a social change and meaning process' (Ibid, p.93). Their model employs mutual reflection as a fundamental underpinning of learning and meaning-making and they acknowledge that initial problem definition is likely to be re-shaped as the project progresses. They assert that, "good sign of learning taking place in an action research project is when the initial questions are reshaped to include newly discovered dimensions". They offer a model of co-generative action research (Figure. 1)

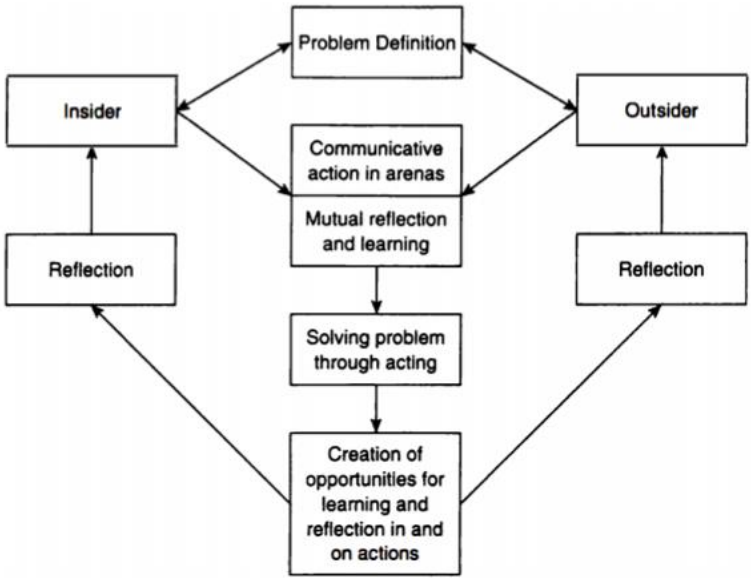

Figure 1. Greenwood and Levin's (2004) Co-generative Action Research Model

In considering Participatory Action Research, Kemmis, McTaggart and Nixon (2013, pp. 4-5), state that "participants have special access to how social and educational life are conducted in local sites by virtue of being 'insiders'". They suggest that this approach affords special access to, and influence on, the practice which is beneficial to research as the researchers are very active in "individual and collective self-reflection that actively interrogates the conduct and consequences of participants' practices, their understanding of their practices, and the conditions under which they practice, in order to discover whether their practices are, in fact, irrational, unsustainable or unjust." They do this rigorously because participants are "profoundly interested in their practices".

3.2 Methodology employed in undertaking this study and preparation of commentary

This study employs mixed methods using a phenomenological approach where the researcher is part of the context being studied (Flyvbjerg, 2011) and the creator of meaning (Robson, 2002). The seven publications are not, per se, about supporting knowledge-creation at disciplinary boundaries and they were not written as a single coherent body of knowledge on that topic. They are a collection of works that develop a number of thematic elements described here as: Actions (the methods and tools employed); Attitudes (the characteristics of the practice environment); and Actors (the multi-disciplines and roles of those involved) that collectively describe and support praxis within the research site. Their analysis, as a data source, together with iterative cycles of generative exploration and interpretation, has allowed the author to establish a conceptual model of design, termed Co-Speculative Knowledge Venturing, through which, when deployed within an educational setting, new knowledge in three different domains is created.

In preparing this submission, the author's generative exploration of meaning in the publications as a body of knowledge is a form of Research Through Design (Frayling, 1993) where the materials of designing are the concepts, ideas and findings present in the selected publications. The author's tacit knowledge, established over the course of his career and particularly during production of these publications, is also material.

Synthetic idea generation, part of design activity, can be seen as a form of sense-making (Kolko, 2010) involving iterative cycles of divergent and convergent thinking and action. The creative act of seeking to establish solutions to incompletely understood problems can also be seen as a research activity as suggested by Dorst and Cross (2001) who identify that exploration of solution-space and understanding of problem-space co-evolve with each informing the other. Swann (2002, p.51) in drawing parallels between design practice and action research suggests that "Design research is tied to a domain that derives its creative energy from the ambiguities of an intuitive understanding of phenomena".

The author suggests that these design approaches, when deployed in pursuit of understanding particular phenomena, contribute to a rigorous and valid research methodology.

In conducting this study, seeking further meaning in the data represented within the body of knowledge, the author has, therefore, employed design as a research method, engaging in a series of divergent and convergent iterative cycles of sense-making and creation (Figure 2).

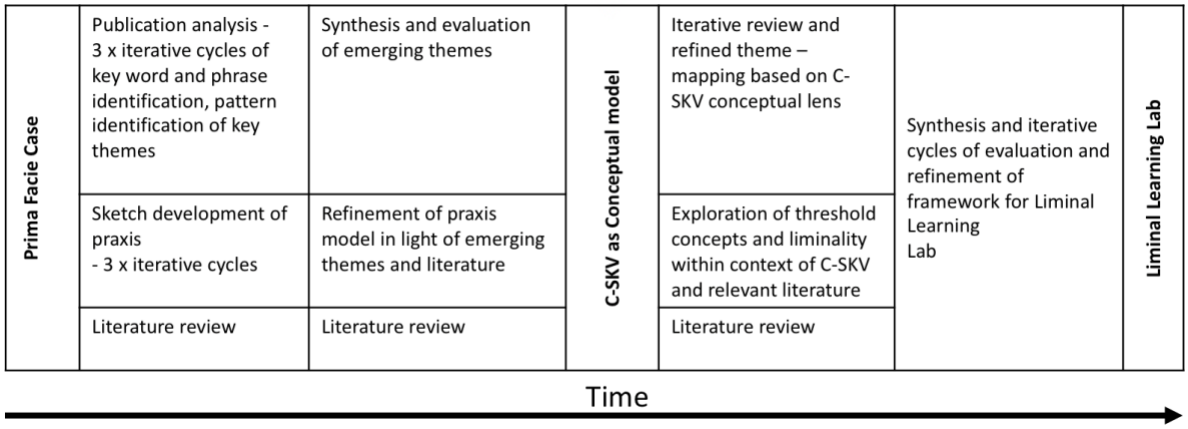

Figure 2. Iterative design approach used in preparation of this commentary

Whilst reflecting on the original practice of conducting the research presented in the publications, each iterative step of developing this commentary has involved reflection-in-action (Schön, 1987), where the author has continually considered the effectiveness of his practice. Further, the overall study has also employed a form of reflection-on reflection-in-action (Ibid.) where the author has retrospectively considered the effectiveness and validity of his reflection-in-action in each step so to understand what has been going on in order to refine and improve the next step.

3.3 Research stance of the author

Unlike action research in Social Sciences as described by Greenwood and Levin (2007), the research represented in the publications has been conducted through a research site primarily interested in education. This means that, in addition to the insiders (partner, problem-owners) and outsiders (researchers) in each project, there are also novice researchers (students).

The Integrated Academic Practice model [3] adopted within MDI means that in addition to their tutoring role, the academics adopt two further positions: outsider researcher within the action research of each project (i.e. external researcher/participant adding value to the partner) and insider researcher within the context of the community of practice (i.e. insider researcher interested in the practice of the research at a macro level). This is because each project forms part of a suite of activities undertaken as both education, knowledge exchange and research

activity within the community of practice. An overlay on Greenwood and Levin's co-generative action research model starts to illustrate this (Figure 3).

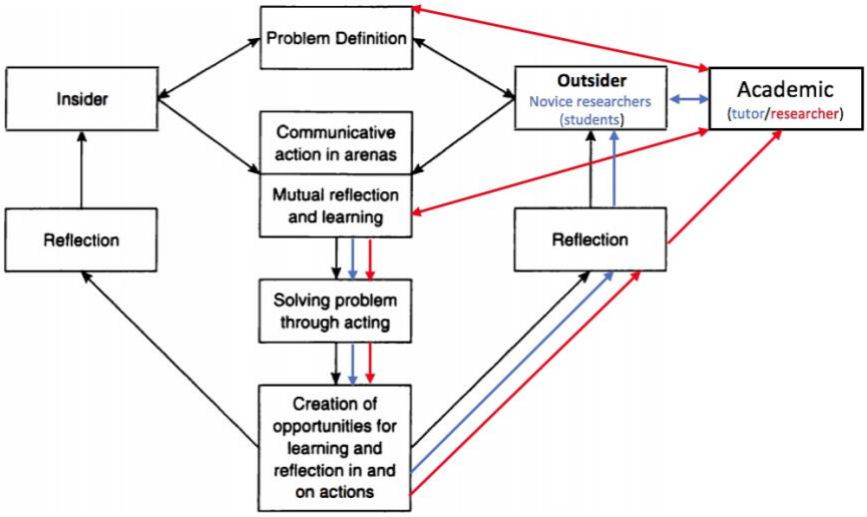

Figure 3. Overlay on Greenwood and Levin's (2004) Co-generative Action Research Model

It is from this stance of participant-outsider/insider that the author developed this submission. The publications have been developed essentially as stand-alone studies, and only now, by adopting an outsider role, treating the body of work as a holistic collection of data, is the author able to theorise and present a unique contribution. As such, this constitutes the phenomenological nature of the study: reflection and investigation of phenomena from the contexts of practice in order to make sense and derive meaning from the whole.

4.0 PUBLICATION ANALYSIS

Collectively, the publications represent research through and into design and they reveal knowledge both about design and designing; about the situations of various design projects; and about pedagogic practices. As such, it is only through deconstructing their meaning as an holistic body of knowledge, and reviewing the data through a different conceptual lens that the nature and value of the collective knowledge contained within them is revealed.

Critically reflecting on this evaluation, it is evident that, whilst rigorous in their production, review and publication, the publications' overriding focus is on presenting the *outcomes and impacts* of engaging in the practices of MDI. This serves as validation and justification, but does not necessarily reveal any particularly generalisable theory but rather presents a series of useful heuristics. The author has addressed this by deconstructing the meaning within each publication and then reassembling this, first as an explication of praxis, then as a conceptual model and finally as a framework to support knowledge-creation in multidisciplinary education. A summary of these steps is presented as Research Through Design in Appendix 4.

Table 2, presents a summarised analysis of the publications' key themes and main findings.

Publication Analysis			
	Title	***Key Theme(s)***	***Main findings***
1	'Safe Environments for Innovation-Developing a New Multidisciplinary Masters Programme'	Rationale for, and approach to, design-led multidisciplinary education situated in organisational challenges	**Importance of establishing a 'safe' learning environment that frees students of inhibitions**: - physical & mental space for experimentation and 'why?' questionin - self-awareness through reflexivity - **multidisciplinary community of practice** and purpose with a 'common language
2	'New Design is Bigger and Harder-Design Mastery in a Changing World'	Master's education in the context of the changing role of design	Emphasis on **multidisciplinary design** for innovation in an **expanded field** Delivering impact through individual **'Designerly Purpose'**
3	'Making it Work; Integrated Academic Practice'	Academic practice across portfolios: Research, Education, Engagement	Enabling conditions to support academic balance: - **'authentic', relevant learning** through reflective design-led practice - **applied research** - **knowledge exchange leading to impact**
4	'Framing Strategic Value through Design-led Innovation Practice'	University/'industry' collaborative projects Multiple value creation Enhanced impact potential	Introduces 'value frames' and identifies three different types of value to partner organisations: - co-created strategy - creative functionality - leveraging strategic change **Students as co-researchers**
5	'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?'	Employability Post-disciplinary education	Role of design (thinking) as an **experimental** approach in an **atypical field** Positions art and design pedagogies as powerful in developing employability (or soft) skills and **creative confidence** Highlights role of designerly methods applied in an expanded field
6	'A design-led approach to transforming wicked problems into design situations and opportunities'	Design-led multidisciplinary co-creation	Establishment of designed **'enablers'** that support effective participation of non-designer experts in co-creative practice by supporting development of **creative confidence** 'What-if?' questioning as a key enabler
7	'The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum'	Design-led multidisciplinary innovation education, framed as Design Thinking	Stakeholder priorities as drivers of programme change and curricular currency and relevance Transition from teaching programme to **research-oriented community of integrated academic practice**

Table 2. Themes and findings represented in publications

In seeking to separate outcomes and impacts, the author arrived at three key and distinct elements essential to the MDI praxis which have been characterised as Actions, Attitudes and Actors cross-referenced to the author's publications shown in red text (Table 3).

Practice Elements	Characteristics of element identified in publication
ACTIONS: Practices, methods & tools (Predominantly design-led and comprising existing, adapted, hybrid and new)	Existing (within disciplines) 5, 6 Experimental 6, 4
ATTITUDES: Environmental factors influencing behaviour (constituted of physical space, pedagogic practices, positive attitude, project contexts and situations)	'Safe' and nurturing 1, 2, 5, 7 Research focused 3, 4
ACTORS: (multi-) Disciplinary upbringing (Formal and informal learning (knowledge, skills and attitude) particular to a given discipline)	Extant knowledge, skills, attitude 1, 2 Speculative knowledge, skills, attitude 5, 7

Table 3. Emergent key thematic elements

4.1 Narrative thread

'Safe Environments for Innovation – Developing a New Multidisciplinary Master's Programme' [1], reports on the aforementioned HEFCE-funded pilot study through which the author revealed the critical conditions required for establishing a suitable learning environment within which the emerging practices of Design Thinking might be taught. The work was undertaken within the context of a growing understanding of the importance of multidisciplinarity. It describes how the findings of this pilot were deployed in the design of MDI. The study reveals the importance of establishing a **multidisciplinary community of practice** as fundamental to providing a safe environment that supports experimentation and reflection.

Exploring the broader context of postgraduate study in design, 'New Design is Bigger and Harder: design mastery in a changing world' [2] builds on findings from publication 1, and subsequent action research and practice developed through MDI, to reinforce the importance of multidisciplinarity in design operating in an 'expanded field' (Leerberg, 2009; Dorst, 2015). It presents the concept of '**designerly purpose'** the object to which an individual focuses their designerly capabilities in order to bring about positive change.

'Making it Work: Integrated Academic Practice' [3] situates the pedagogic principles developed in the preceding publications within the context of the three portfolios of contemporary academic practice; research, education and knowledge exchange (REF, TEF and KEF[3]). It suggests that project-based activity with external partners can offer a situation that promotes high-quality, pedagogically sound, '**authentic', relevant learning** (Donovan, Bransford, and Pellegrino, 1999) whilst offering a research site from which to gather data and in which to validate new knowledge. This publication presents a model of Integrated Academic Practice, IAP, which supports this activity.

[3] REF, TEF, and KEF are UK Government frameworks for evaluating Research Excellence, Teaching Excellence and excellence in Knowledge Exchange respectively.

Integrated Academic Practice delivers benefit to stakeholders in each academic portfolio; students benefit from relevant, authentic learning (Donovan, Bransford, & Pellegrino, 1999); the disciplines benefit from academic research and partner organisations benefit from knowledge exchange pertinent to their situation. 'Framing Strategic Value through Design-led Innovation Practice' [4] reveals three particular forms of benefit that emerge from this type of multidisciplinary practice. These are positioned as 'value-frames'. The research for this publication was conducted using a case-study methodology, which identifies two specific aspects of the practice of the projects as particularly significant to the value achieved. These are 'Form Position': essentially setting the creative brief for the project following initial research and 'Communicate Narratives': identifying and deploying the most effective and appropriate forms of communication to reach intended audiences of the work.

The significance of this publication in relation to this submission is twofold: it highlights the importance of forming a position which the author has identified as the essential outcome of constructive, synthetic creative compromise and for students it highlights the genuine value of their work to the organisations with whom they work as they study through IAP projects – **it identifies them as co-researchers.**

The expansion of the field in which design has influence underscores the importance of design-led, multidisciplinary innovation education. 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' [5] reports on an **experimental** pilot study in which Design Thinking approaches were employed with a multidisciplinary group of students in order to explore higher education in the context of future employment. As well as demonstrating the relevance of applying a designerly approach in an **atypical field** (developing education), it also reveals the value of adopting Design Thinking as a pedagogic approach that is effective in developing employability skills, amongst students.

'A Design-led Approach to Transforming Wicked Problems into Design Situations and Opportunities' [6] builds on this application of design in an expanded field as it presents a case study of design-led innovation in the context of a cyber-crime project. It establishes six **'enablers',** which support the growth of creative confidence amongst non-design stakeholder participants. The significance of this work to this submission is that it demonstrates the integrated role of **Actions, Actors and Attitudes** (enablers) in the development of new knowledge for the project situation, about the methods and tools of design and for individuals as they transition from expert participant to co-creation activist.

'The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum' [7] explores the design, and iterative development of the MDI programme over a period of ten-years. It establishes how the programme has transitioned from being simply a teaching programme to a **research-oriented community of integrated academic practice.** It reveals the importance of stakeholder priorities as drivers of curricular currency and relevance. As such, it presents the programme as having a fluid curriculum simultaneously determined by the contemporaneous pressing needs of students (as future employees), business (represented by partnering organisations), society and academia. The study reveals the underlying pedagogic principles and aspects of delivery that have ensured that these values are delivered.

5.0 LITERATURE

The following chapter sets out a contextual review of eleven fields of knowledge that the author has identified, through his thematic analysis of publications and explication of praxis, as pertinent to, and locating, this work. These form the basis of literature review summarised below and set out as guiding positions tabulated at the end of this chapter (Table 4). It is indicative of the iterative development of the author's developing interpretation and understanding of his unique contribution to knowledge that not all of the literature referred to here appears in the original publications upon which his submission is based.

5.1 Design

MDI is not concerned with studying to be a designer, per-se, but the practice that this study is exploring has its roots in design and is underpinned by certain fundamental principles found in design practice and education. In order to ground this work, it is important to position it, epistemologically, within design.

Two prominent schools of thought dominated the design discourse of the late 60's and 70's; they remain to this day. Christopher Alexander summed-up the role of design as to give form and organisation to material objects: "the ultimate object of design is form" (1964, p.15). Alternatively, Herb Simon (1969, p.114) was not so much interested in the form of artefacts, but in the role of design to determine "how things ought to be", to create a desired state of affairs in a given situation. Whilst Simon sought to determine a structured science of design that responded to well-ordered problem situations and the author is more concerned with complex, ill-structured problems, it is, nonetheless, Simon's more expansive, research-oriented role of design, to determine how things ought to be, that underpins the author's work.

5.2 Reflective Practice and Design Learning

In the context of design learning, Kolb and Fry (1975) set out the importance of reflecting on new experiences as part of a cycle of studio-based experiential learning.

Schön, in 1987, presented the design process as reflection-in-action in which the designer engages in a "reflective conversation with his materials". Through such conversation the designer seeks to control certain variables in order to experiment and test out emerging hypotheses. "He produces knowledge that is objective in the sense that he can discover error – for example, that he has not produced the change he intended." (Ibid., pp. 78-79). He goes on to explain that personal knowledge, learning from doing, is developed with each cycle of the design process and this, in turn, informs that process the next time it is enacted. This is as true for the professional designer as it is for the novice. However, the novice designer needs to be coached in order to become adept at reflecting-in-action as opposed to retrospectively reflecting-on-action. In relation to this submission, Schön's perspective is just as valid when the materials of design are the intangible elements of systems, services, business strategies and policies.

Schön suggested that a setting designed for learning a practice, a 'practicum', should be a "virtual world, relatively free of the pressures, distractions, and risks of the real one, to which, nevertheless, it refers". He goes on to explain how the practicum embodies "particular ways of seeing, thinking and doing that tend, over time, as far as the student is concerned, to assert themselves with increasing authority" (Schön, 1987 p.37). Within the practicum, students embark on a journey to learn 'the practice of the practicum' in order to get from where they are to where they want to be. They do so through a combination of 'learning by doing',

interaction with peers, coaching from tutors and ‘background learning’, which is a form of unconscious assimilation of habits, rules and procedures of the practice (Ibid. p.38).

5.3 Designerly ways of knowing

The author proposes that the combination of formal and informal learning within a particular field, be considered a ‘disciplinary upbringing’, which contributes to discipline-specific ways of knowing similar to ‘Designerly Ways of Knowing’ (Cross, 1982).

Expanding on Archer et al.’s previous work (1979) exploring the role of design in general education, Cross (1982, p.226) sought to represent the particular ways in which designers work and think and the sort of problems they tackle as “five aspects of designerly ways of knowing:

- Designers tackle ill-defined problems.
- Their mode of problem-solving is solution-focused.
- Their mode of thinking is ‘constructive’.
- They use ‘codes’ that translate abstract requirements into concrete objects.
- They use these codes to both ‘read’ and ‘write’ in ‘object languages’.”

Within the contemporaneous debate about the role of design education in general education, Cross identified its benefits to developing real-world problem-solving, sustaining cognitive development and development in a “wide range of abilities in nonverbal thought and communication” (Cross, 1982, p.226) – such qualities are now grouped amongst the ‘soft-skills’ most sought by employers [5]. These soft skills, especially in regard to creativity and problem-solving, are increasingly important as the nature of the situations that society faces become more complex, networked and dynamic.

5.6 Design problems (and solutions)

Rittel & Webber (1973) introduced the term ‘wicked problem’ to draw attention to the sorts of messy problems, lacking clarity in both their aims and solutions, that designers face. Such problems are increasingly ill-defined, networked, dynamic and seemingly intractable (Dorst, 2015). As previously noted, Dorst and Cross (2001) proposed that problem and solution co-evolve. Dorst (2004, p. 141) explained that

> Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation processes between the two notional design ‘spaces’ - problem space and solution space. In creative design, the designer is seeking to generate a matching problem-solution pair, through a ‘co-evolution’ of the problem and the solution.

His subsequent work on Frame Creation in design (2015) has sought to offer means by which design problems might be framed in order to make them more manageable by offering different perspectives on the problem that engender new understanding and provide bridges to potential solutions.

Such wicked-problems provide the subject-matter for MDI learning although the author prefers to use the more positive terms of ‘situation’ and ‘opportunity’ in place of ‘problem’ and ‘solution’ [6]. These situations can be found in circumstances previously considered atypical for design.

5.7 Design in the Expanded Field

Whilst discussion about the field of practice of design has been part of the design discourse for decades it has crystallised into notions of Design in the Expanded Field. Malene Leerberg (2009, p.1) explained that:

> As contemporary design increasingly transcends the idea of merely tangible, material objects to include more elusive creations such as interactions, strategies and systems, we might also note that contemporary designers are no longer the sole contributors to the creative process of designing; often designers participate in interdisciplinary communities of practice.

Importantly, this draws into focus the idea that it is not only designers who may be involved in the act of designing. She continues

> design has become more elastic, and contemporary design has transformed into an interdisciplinary practice, crossing boundaries to science and humanities – the knowledge spheres of theory and interpretation.

Freidman (2005) makes the connection with an expanded field in which Simon's (1969, p.111) idea of design determining "courses of action aimed at changing existing situations into preferred ones" unifies multiple fields and practices.

Dorst (2015) recognises the expansion of the field of design, but considers the importance of "protecting the rigor and coherence of the discussion within this expanded field" in order to avoid fragmentation or scattering. He concludes that: "Eventually, we will have to move to a new, dynamic definition of design as an expanded field" (Ibid. p.33). The important thing in this discussion is that it is not just the field of application of design that is expanding, but that the practices of design, and consequently design education, need to expand in order to service them. Design Thinking has emerged, for some, as a 'catch-all' concept that legitimises design activity in an expanded field.

5.8 Design Thinking

Design Thinking as a concept is, simultaneously helpful and unhelpful. A notion first articulated in some detail by Peter Rowe in his 1987 book 'Design Thinking'. Rowe focused on 'procedural aspects of design thinking' and highlighted the hunch-based, intuitive, episodic way in which design professionals work. He also argued that solutions are shaped by the problem-solving approach employed (Ibid.).

The literature surrounding Design Thinking fails to offer a single, accepted definition. Baker III and Moukhliss (2020, p.3), in their systematic literature review of Design Thinking and human-centred design describe it thus, "a problem-solving approach which reduces a number of broad design methods into a simple, replicable framework, and is utilised in an ever-increasing number of settings to address a growing variety of challenges".

Martin (2009, p.6) described Design Thinking as a "dynamic interplay" that balances "analytic mastery and intuitive originality" and he focuses on the different cognitive styles of the worlds of design and business. Contemporaneously, Tim Brown (2009), the global design firm IDEO and others sought to codify Design Thinking with IDEO preferring the three-phased 'inspiration, ideation, implementation' model, whilst Kelley and Stanford's d:School have popularised the five-phased 'empathise; define; ideate; prototype; test' approach. These processes, with their declared purpose being to bring the benefits of design to business thinkers, appear to remove the 'thinking' from the activity, replacing it with a procession from one stage

to the next. However, a fundamental aspect of Brown et al.'s thinking is the importance of multiple disciplines collaborating in Design Thinking. Further, Brown as CEO of IDEO and the Kelley brothers as founders, adopted the "fail early and fail often in order to succeed sooner" mantra as the firm's guiding principle and saw this as foundational to Design Thinking as a learning activity. Both of these aspects are important in the context of this submission [1 & 7].

Martin (2009), rather than focusing on a processual approach considers what it means to 'think like a designer'. He builds on the idea that there are three forms of logic: deductive (the logic of what must be), inductive (the logic of what is operative) and abductive (the logic of what might be). He argues that most organisations are structured to operate using the first two types of 'declarative' reasoning only. These are safe, because they are based on history - the data tells us that if we do what we did before there's a good chance that the results will be unsurprising and this is *reliable* (and, therefore, good). His notion is that a focus solely on reliability stifles innovation and that organisations need to balance this with what he calls '*validity* thinking', which is based more on insight and intuition about imagined, preferred futures which can't be proved because they are in the future. He puts forward a model of advancing knowledge from a mystery, through heuristics (conceptual rules of thumb) to algorithms (tried and tested and repeatable ways of doing things). Robust organisations, he argues, employ this form of Design Thinking to balance reliability and validity thinking to ensure that they are always exploring the mysteries of the future whilst making money from the solutions of today.

Lucy Kimbell (2011, p.297) in Part 1 of her article Rethinking Design Thinking suggests that there are three identifiable accounts: Design Thinking as a cognitive style; Design Thinking as a general theory of design and Design Thinking as a resource for organisations. The author finds that Kimbell's way of framing Design Thinking is helpful. Whilst his own view aligns most closely with that of Martin's regarding 'thinking like a designer', Kimbell's approach is helpful because it allows Design to be accessible to different audiences, in different situations, who may not otherwise have considered design at all.

Within an educational context, Rauth et al. (2010), in their study 'Design thinking: An educational model towards creative confidence' found that through repetitive cycles of engaging in Design Thinking a particular mindset was developed, which in turn built creative confidence.

> [C]reative mindsets are fostered by repetitively experiencing and applying the process as well as tools according to given problems or developing behavioural patterns in certain situations. These mind-sets can be seen as the establishment of a bias towards creative behaviour in situations where students are facing situations in which they are uncertain or problems where there is no solution at hand. (Rauth et al., 2010, p.6)

Jen (2017) in her critical TED Talk, 'Design thinking is Bullsh*t', summarised it as "codifying [designers'] processes into a prescriptive, step by step approach to creative problem solving, claiming that it can be applied by anyone to any problems". She suggests that these processes lack evidence-based evaluation and the critical steps of design critique. This is, potentially problematic if Design Thinking is adopted as an educational model (Rauth et al., 2010) as the design critique is perceived as a signature pedagogy of design (Shulman, 2005; Shreeve, 2015). As will be seen, the author's MDI programme addresses this potential short-coming.

5.9 Creative Confidence

'Creative confidence' refers to people's belief in their ability to change the world around them through courageously trying out new ideas (Kelley and Kelley, 2013). The concept relates closely with that of self-efficacy - an individual's belief in their own capabilities "to mobilise the motivation, cognitive resources and course of action", required to reach self-determined goals (Bandura and Jourdan, 1991, p.952). Creative confidence is described by Kelley and Kelley (ibid) as lying "at the heart of innovation" as it requires us to face challenges and take risks (Phelan and Young, 2003).

Design-led approaches to solving wicked problems involve using the mind-set and tools of a designer and require the creative confidence to act decisively and take risks (Rauth et al., 2010; Kelley and Kelly, 2012; Ulibarri, et al., 2014). Furthermore, Kelley and Kelley suggest that creative confidence is progressive and adds to and enhances existing practices rather than replacing them.

The majority of design literature focuses on the individual although Baer et al. (2008) refer to 'team creative confidence' and 'collective efficacy' when this confidence is directed towards a shared goal by individuals acting collaboratively. The author's work is, however, particularly focused on, not only team-based design activity, but specifically multidisciplinary team-based design activity.

5.10 Group learning and social construction of knowledge

According to Davidson & Major (2014) three main models of group learning have emerged in the literature over the past 4 decades; Cooperative Learning; Collaborative Learning and Problem Based Learning. They all rely on the social construction of knowledge and share a number of characteristics including reliance on individual accountability & responsibility and interdependence in working together. Cooperative Learning typically requires a more structured, tutor-led, approach whilst Collaborative Learning is more suited to open-ended questioning and self-organisation. Problem Based Learning is dependent on real-world problems for student groups to solve and in some models, the tutor transitions from instructor to facilitator (Ibid.).

"Constructivist philosophy asserts that students make their own meaning" (Davidson & Major, 2014). Vygotsky (1978) suggests that knowledge is a social product and that an individual's learning results from their interactions with fellow learners and tutors and that learning happens at the social level before the individual level.

In comparing Cooperative and Collaborative approaches, Bruffee (1995) identifies that, in order to benefit from such learning, some re-acculturation may be needed. By this he means renegotiation of membership in groups or cultures by modifying our "participation in the language, values, knowledge and mores of communities we come from as well as becoming fluent in the same elements of the communities we are trying to join" (Ibid. p.14). In other words, we have to give up something of one identity in order to take on something of another. He suggests that a "teacher's job is to re-acculturate students into groups whose common property is one or another kind of knowledge", knowledge which he says the group constructs.

5.11 Threshold Concepts and Threshold Capabilities

Meyer and Land (2005, p.373) propose that, "in certain disciplines there are 'conceptual gateways' that lead to previously inaccessible, and initially perhaps 'troublesome', ways of thinking about something". They termed these 'Threshold Concepts' and initially characterised

them as Transformative; Irreversible; Integrative and Troublesome. Osmond, Bull and Tovey (2009, p.2) explain that passing through the 'knowledge portal' involves entering into a state of liminality. "[W]hilst students are trying to grasp a threshold concept, they experience a sense of uncomfortable intermediacy, while they struggle for understanding, and this struggle can involve identity shifts"

Whilst Threshold Concepts within the study of design have not been researched in any great detail, Osmond, Bull and Tovey (2009) and subsequently Osmond and Turner (2010, p. 13) have identified that the tolerance of liminality may be helpful to designers: "it is the *process*- the toleration of uncertainty – that brings about the transformation in the student, and this achievement of tolerance is linked to an increasing confidence in their own capability and identity as a designer"

Lam et al (2018) reinforce the relevance of the liminal space to design practice: "Co-design can be seen as a practice that guides people, especially those not trained in design, through different stages of liminality" and highlight co-design, a practice of engaging 'non-designers' in designerly activity, as supportive within the liminal space.

Baillie, Bowden and Meyer (2013) expand on Threshold Concepts and consider Threshold Capabilities. They define these as, "those capabilities that are in fact threshold to professional learning in a defined area of knowledge" and the capability, underpinned by the threshold knowledge, to be; "able to explore the consequences [of newly acquired knowledge] in new situations" relevant to the field. This builds on Meyer and Land's theory that passing through certain knowledge portals may equip learners for given professions by enabling them to think like (for example) an engineer.

Osmond and Turner's (2010) 'toleration of uncertainty' is one such threshold capability that experienced designers develop, and it is of particular significance to this study and a capability that would enable individuals to question orthodox knowledge in pursuit of new possibilities [1, 6 & 7].

The significance of understanding and mastering the discomfort of travelling through states of liminality is in the profound effect that learning in this way can have on the individual and their future self: "Threshold concepts lead not only to transformed thought, but to a transfiguration of identity and adoption of an extended discourse." (Meyer and Land, 2005, p. 375).

Tovey et al. (2019, p.75) describe "[t]he portal where there will be variations in how well they handle an unsafe space, and whether or not they can pass through it." This underlines the importance of creating a safe environment in which students can undertake 'unsafe' learning journeys [1].

5.12 Guiding positions

Praxis within the MDI community has been established over the past twelve years founded on a series of positions drawn from the literature hitherto described. Table 4 identifies these principles.

Guiding position	Authoritative voices
Role of design is to determine "what ought to be" [7]	Simon, 1969
Constructivist 'Learning by doing' underpinned by reflection are fundamental pedagogies supporting experimentation and 'learning by brave failure' [1]	Kolb and Fry, 1975 Schön, 1987
Multidisciplinarity is fundamental to addressing wicked problems through design thinking [1, 2, 5 & 7]	Brown, 2009
'Designerly ways of knowing' and doing need not be the sole preserve of designers [5 & 6]	Cross, 1982
Design can be as valuable in helping to interpret situations and navigate ambiguity as it is in 'solving' them when addressing 'wicked problems' as problem and solution co-evolve [4 & 6]	Dorst and Cross, 2001 Rittel and Webber, 1987 Buchanan, 1992
Design's scope of useful application can be seen to exist within an 'expanded field' in which designers are not the only creative actors but design can illuminate and unify a multitude of fields and practices [3, 5 & 6]	Leerberg, 2009 Freidman, 2005
Balancing analytic mastery with intuitive originality with its focus on the importance of 'abductive logic' is critical to engaging multiple disciplines [1]	Martin, 2009
Creative practice underpinned by facilitated reflection helps to develop a mindset of Creative Confidence [5]	Kelley and Kelley, 2012
Social construction of knowledge relies on individual accountability, responsibility and interdependence. Coupled with reflection this supports development of 'designerly purpose'[2]	Taylor and Major, 2014 Bruffee, 1995 Johnson and Johnson, 1994
As students pass through conceptual thresholds they spend time in liminal space as they grapple with troublesome knowledge. A safe environment is essential to supporting such liminality [1 & 7]	Meyer and Land, 2005

Table 4. Guiding positions and authoritative voices
(Author's publications cross-referred in red text)

6.0 CONCEPTUAL LENS: Co-Speculative Knowledge Venturing

Through the process of iteratively drawing-out a model of the praxis described within the seven publications, the author has devised the concept of Co-speculative Knowledge Venturing, C-SKV. It is offered as a conceptual lens through which to consider design within the practicum of MDI. The concept is based on the collaborative use of generative design methods and approaches to explore collective, but incomplete, knowledge in a project situation. C-SKV is based on the notion that new knowledge-creation and understanding are achieved at the intersection of disciplinary knowledge and practice boundaries and that such knowledge can be deployed in order to explore and evaluate possible futures. This is helpful in navigating the ambiguity of defining and responding to wicked problems. This knowledge-creation is dependent upon project participants developing the creative confidence to venture heuristics, conceptual 'rules of thumb', (Martin, 2009) within the group. That creative confidence is established through repetition within a 'safe environment', e.g.: the MDI practicum [1].

Co-speculative Knowledge Venturing (Table 5) is the group act of design at the core of multidisciplinary idea generation that forms the basis of the project direction and establishes the frames within which the project situation will be explored. The group speculates about combinations of knowledge and ventures suggestions about possible futures based on these combinations. The approach relies, predominantly, upon verbalisation and the use of questioning (especially "what if?"), but may involve other forms of externalising, such as

sketching, storytelling, low-fi prototyping [4] etc. to help members of the group understand 'tricky' concepts. This group speculation of new knowledge combinations, and venturing about potential futures, forms the basis of synthetic, constructive, creative compromise as the group seeks to establish a 'common purpose' [6 & 7] (also referred to as 'form positions' [4 & 6]). This common purpose, in effect, becomes the multidisciplinary project brief and establishes a bridge between what we know now and what we can imagine for the future. C-SKV involves the group sharing their tacit knowledge of the situation, positing initial thoughts and ideas and highlighting things that they don't know, but think may be important. There is not a formalised structure to C-SKV, nor a prescribed timescale or method - these things are determined by the needs of the situation and the speculative knowledge that is forthcoming.

Co-Speculative Knowledge Venturing, C-SKV	
Co-llaborate:	'To work jointly with others or together especially in an intellectual endeavour'
Speculate:	'To meditate on or ponder a subject; to assume a business risk in hope of gain; to take to be true on the basis of insufficient evidence'
Knowledge:	'The sum of what is known: the body of truth, information, and principles acquired by humankind'
Venture:	'To proceed especially in the face of danger; to offer an opinion, idea, suggestion etc. at the risk of rebuff, rejection, or censure'

Table 5. Co-Speculative Knowledge Venturing (definitions: Lexico.com, 2020)

Within the practicum, expert design facilitation is used to help participants become more accepting of ambiguity through framing and re-framing complex situations (Dorst and Cross, 2001; Dorst, 2015). Collaborating in mixed-discipline groups to explore multiple innovation opportunities arising from this re-framing, supports the development of individual and collective Creative Confidence (Kelley and Kelley, 2014).

In consideration of 'expert design facilitation' the author reflects that questioning is a principle enabler within the practicum [6]. Questions are typically derived from Sinek's (2009) 'golden circles' concept in which he suggests that great leaders inspire action through focusing, not on the solution; 'the what', nor on the means; 'the how'; but on 'the why' – the purpose of the venture. This simple device is joined by the question most often asked within the practicum; "what if?". De Bono's (2015) 'provocations' are akin to the "what-if?" questions discussed here; used to move the mind to an unlikely, or hitherto unconsidered, place. "A provocation usually tries to be "unreasonable" in order to jerk our thinking out of its usual channels". If a useful idea springs from this it can be retro-justified "Hindsight justification of an idea is every bit as valid as any other form of justification" (DeBono, 2015, p. 346).

Kimbell (2011, p. 287) describes designers as cultural interpreters who "ask "what if?" questions to imagine future scenarios rather than accepting the way things are done now." In MDI, 'tutors' take on the role of facilitators, coaches and mentors. A tutor's "what if?" question is generally followed by analogy – 'what if it were like this... or this...?' Adopting this speculative stance, the asker is adopting a non-hierarchical and collaborative attitude. For

[4] Low-fi prototypes in this context refer to rapid representations of physical artefacts and communications such as faux-advertisements, posters, business-plans, simulations of websites, apps etc.

many, venturing an idea is to make oneself vulnerable, to open-up the risk of rejection or ridicule. When the asker is the tutor, therefore, a levelling takes place that helps boost the confidence of the students who are struggling with the situation because they can see that the situation is also troublesome to the experienced tutor [1, 3, 4 & 6].

C-SKV can be seen as the means by which students (and other project participants) travel through a project tentatively venturing heuristics and building upon each other's ideas as they create new knowledge about, and for, the project situation. Case studies represented in the publications [4, 5 & 6] illustrate this. "What if?" questioning is recognised as key to transitioning through the why, how and what of the project.

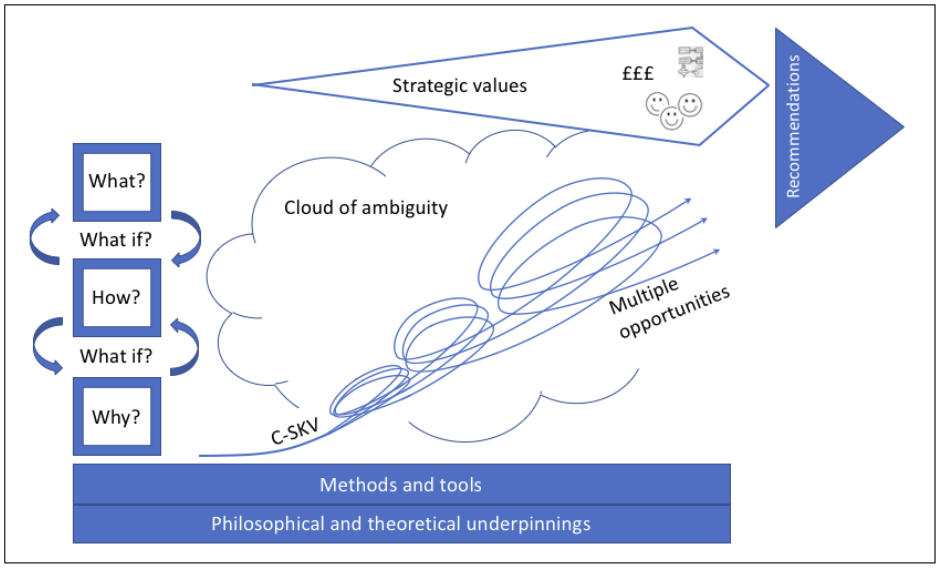

Figure 4: Visualisation of praxis at project level

Figure 4 illustrates how this praxis works at a project-level. Fundamental philosophical and theoretical positions (see Table 4), together with a suite of established methods and tools provide a platform upon which a project is built. Students collaborate to address the cloud of ambiguity represented by the project's complex situation. They employ iterative cycles of C-SKV, which are facilitated by tutor guidance about the appropriate methods and tools to consider using and cycles of "what if?" questioning to aid them in determining the why, how and what of the situation. Multiple opportunities are simultaneously created and these are considered in relation to the nature of strategic value that they represent to the partnering organisation [4]. Knowledge generated through the creation of multiple opportunities and the understanding that these enable is synthesised in relation to the potential value to the organisation. This synthesised knowledge is presented to partner organisations as opportunities and recommendations.

Figure 5 represents how repeated cycles of this practice, with different partners and project situations, contribute to a creative self-discovery for the individual learner, termed 'Designerly Purpose' [2]. Through facilitated cycles of reflection, students develop a self-awareness about what they do (and can do), how they do it and why this matters (to them and others). This developing awareness of what they can do is fundamental to developing self-efficacy and, therefore, to enhancing creative confidence.

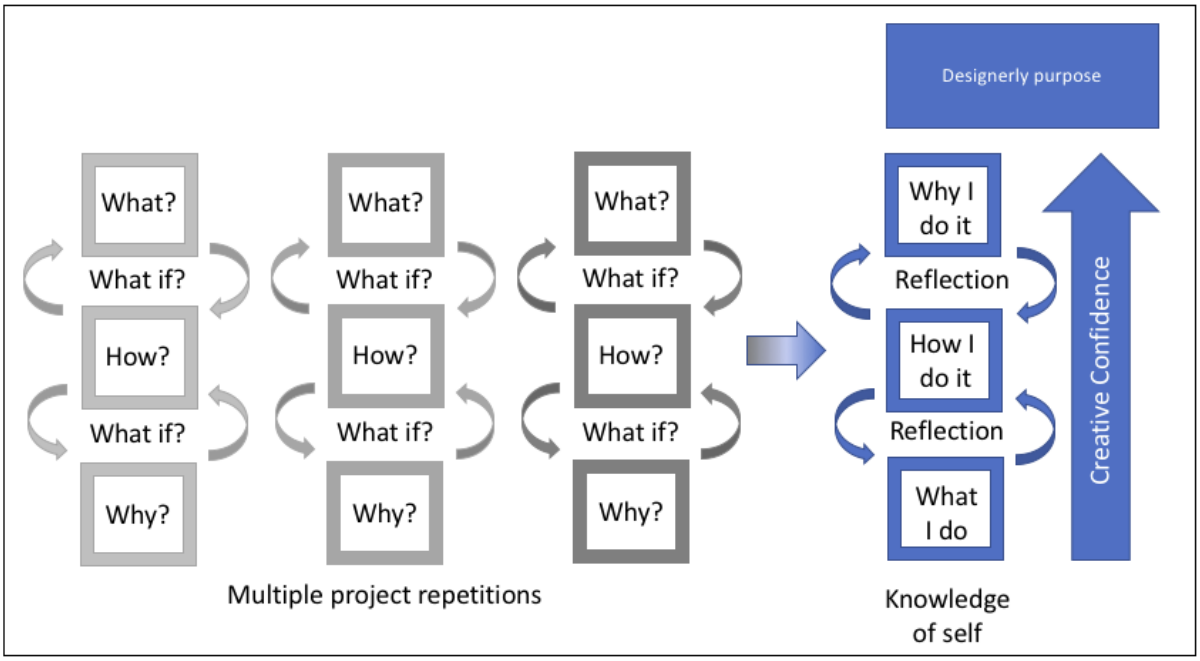

Figure 5: Development of creative confidence and designerly purpose through project repetitions

7.0 THRESHOLD UNDERSTANDING IN C-SKV

Threshold Concept theory focuses on making extant knowledge, pertinent to the study of a given subject, accessible and understandable for learners. Threshold Capabilities position such knowledge within the disciplinary context of given professions.

Transitioning through liminal space in the acquisition of extant knowledge typical of threshold concepts within mono-disciplines is well defined in the literature (Berger, 2004; Meyer and Land, 2005; Osmond and Turner, 2010; Baillie et al, 2013; Tovey et al, 2019).

Whilst there is some limited literature that explores Threshold Concepts and Capabilities in relation to design studies, there appears to be no exploration of these concepts within the realm of multidisciplinary design-led innovation. This is a feature of extant literature being predominantly concerned with modelling design practice, and to a lesser extent, individual design experience, rather than the experience of different disciplines in a team-based design innovation context.

Using C-SKV there are three knowledge domains within which students advance knowledge (Table 6). Given the multidisciplinary nature of the project team, it is entirely likely that, at any one moment in time, members of the team will be grappling with troublesome knowledge in any one, or more, of these knowledge domains.

		Extant knowledge	New knowledge
Knowledge domain	1. Knowledge for and about the project situation	Factual information and insights derived from primary and secondary research	New understanding and representation of the project situation (re-framing) Ideas, insights, concepts and proposals
	2. Knowledge about the methods and tools employed in the project	Existing practices, methods and tools (typically of design and business) employed in research, analysis, synthesis and creation	Adapted, hybrid or new practices, methods and tools to be employed in research, analysis, synthesis and creation
	3. Knowledge about self – what the individual has learned through the course of the project, understood through reflection	Knowledge of personal hard- and soft-skill development Knowledge of known knowledge and gaps in knowledge	Self awareness and designerly purpose Creative Confidence

Table 6. C-SKV knowledge domains

7.1 Edges of knowing and liminality

Berger (2004, p. 338) suggests that for individual learners the edge of knowing is the "most precarious - and important - transformative space". Within C-SKV, teams of students are confronted by ambiguity and are heavily reliant on their disciplinary upbringing. The nature of the multidisciplinary make-up of the team dictates that students will find different aspects of requisite knowledge for the project situation troublesome at different times and to different degrees.

However, within the context of multidisciplinary education settings, whilst students will, undoubtedly, encounter threshold concepts in extant knowledge acquisition, there is a greater challenge; coming to terms with the liminality associated with new knowledge that is not yet known, is uncertain or incomplete. Such knowledge is contained in the yet to be fully-formed genesis of an idea, is made up of fragments of knowledge drawn from multiple disciplines and it only really becomes certain at the moment of manifestation (as a 'designed' output). It is the working material of synthetic creative compromise. Kolko (2010, p. 22) in discussing design synthesis as an abductive, sensemaking process, suggests that the "activity of defining and forging connections actively produces knowledge" but he suggests that, typically, this synthesis is a private act carried out by designers working in isolation and he puts forward an argument for externalising and formalising this process. The MDI context is very different from the privacy that he suggests in that students are not all designers expert in the private 'magic' that he describes. This is a specific benefit of the MDI practicum because it means that students work together in synthesising knowledge and insights from their multiple perspectives drawing on the various thinking-styles and disciplinary upbringings represented in the group.

Martin (2009) positions constructivist, abductive thinking alongside the more positivist deductive and inductive forms of logic. In practice we see that it is often easier to promote these latter forms of declarative logic as robust and rigorous (particularly outside arts and humanities disciplines). Abduction is harder to justify. Indeed, in retro-justifying design decisions based on abduction, designers may adopt a sort of 'false-positivism' where they ask

the observer, temporarily, to take a given concept to be 'true' in order to build an hypothesis around it.

This is a tactic observed within the liminal space occupied by students engaged in C-SKV. As they grapple simultaneously with knowledge acquisition for and about the project situation and the methods and tools employed in understanding and responding to it, different individuals with different disciplinary upbringings inevitably find themselves, at different times, in the transformative space at the edges of knowing. Here the power of the group, with their collective focus on a co-created common purpose [6 & 7], takes over. Peers who are comfortable with a given concept support those who do not, yet, 'get it'. They use a form of storytelling, grounded in "what if?" questioning to aid their peer to leapfrog the troublesome knowledge, to move beyond the liminal space, to consider a plausible future possibility. Within the group, this can happen multiple times with multiple different protagonists taking the lead from their different disciplinary perspectives. The author suggests that in a monodisciplinary or private, solo-designer setting, many opportunities may remain unexplored because troublesome knowledge could get in the way of the necessary conceptual leap.

Within a project, the group may make several conceptual leaps of this kind and there clearly needs to be a critical mass of understanding and acceptance of the emerging hypotheses for the project to maintain forward movement. The role of the story about a plausible future is twofold: it paints a picture that enables peers to visualise, evaluate and critique a concept and, if it gains acceptance, it provides the basis for the students who couldn't grasp the underpinning knowledge with the motivation to try to understand it and an applied example of it within the project situation to help them.

8.0 CONTRIBUTIONS

As previously posited, a design is a manifestation of synthesised knowledge crystallised as a form of temporal certainty. And that synthesised knowledge comprises the multiple compromises, creatively made in the artistry of reaching that temporal certainty (section 2.1). Furthermore, within the context of this study, pursuit of such knowledge involves students in an almost perpetual state of individual and/or collective liminality (section 7.1). The unique contributions of this study are twofold; a conceptual model of multidisciplinary design as Co-Speculative Knowledge Venturing and a framework, dubbed Liminal Learning Lab, to support learners in dealing with the liminality associated with this socially created knowledge in the learning environment (Figure 6).

8.1 Co-Speculative Knowledge Venturing

C-SKV, as described in section 6.0 differs from such movements as Participatory Design (PD) or Co-Design in that its context of application is specifically educational – it is offered as a means through which collaborative, generative enquiry is conducted in a safe environment [1] with the purpose of generating new knowledge for and of the project situation, about the practices, methods and tools of design-led innovation and, for the students, of self. Whilst Participatory Design does employ similar generative research approaches the purpose of these 'is to discover as-yet unknown, undefined, and/or unanticipated user or consumer needs' (Sanders, 2002). The overall aim of PD being to democratise design for the creation of designed outputs for users or consumers, rather than for learning. In CSKV, on the other hand, designed outputs are merely a beneficial consequence of the enquiry, as evidenced by the assessment of learning, not of outputs, in the students' 'portfolios of practice' [1; 7].

8.2 Liminal Learning Lab

The Liminal Learning Lab framework is valuable in that:

- It provides guidance and structure for academics seeking to develop and deliver multidisciplinary education involving forms of group and enquiry-based learning in any context. For example, in situations where institutions are developing new modules or programmes of study the author proposes that this framework may be used to inform that design and to evaluate its effectiveness;
- It provides a formalised structure through which students engaged in multidisciplinary learning might understand what is going on. For example, students, with their tutors, can use the framework to chart projects' progress and their own development within them. Through repetition, they will start to recognise and predict project phases and be better able to embrace liminality as a positive, transformational, experience. Furthermore, tutors can use the framework to help them monitor and adapt projects in tune with students' experiences and performance;
- It forms a basis for further research into liminality in multidisciplinary knowledge-creation within social learning settings by highlighting the key areas of interest.

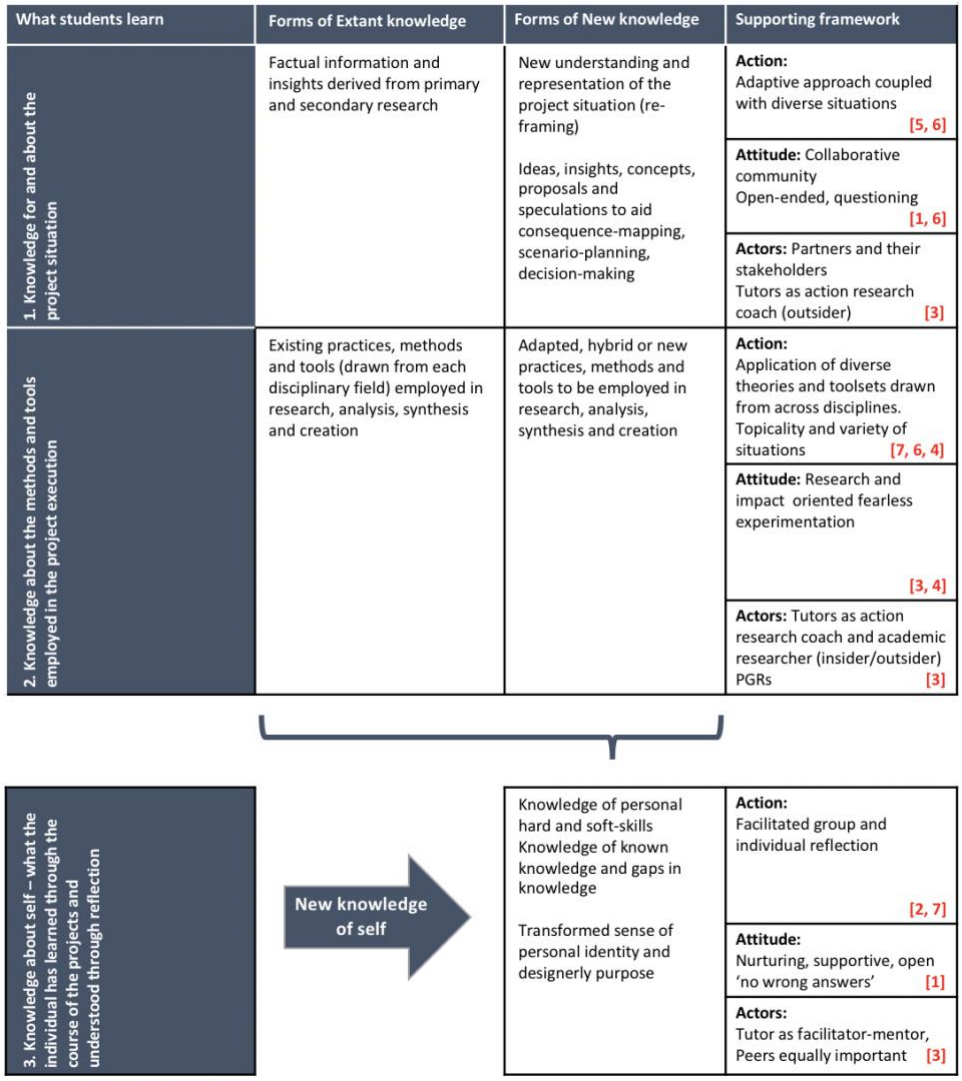

Figure 6. Framework in support of Liminal Learning Lab
(Author's publications cross-referred in red text)

Within each knowledge domain, supporting pillars of Actions; Attitudes and Actors are described:

1, **Knowledge for and of the project situation:** Actions focus on the importance of providing varied project situations and employing an adaptive approach suited to each situation. Attitudes are collaborative and involve open-ended questioning revolving around "What-if?". The involvement of partner employees together with their stakeholders as key actors is emphasised alongside peers and tutors taking an action research coaching role.

2, **Knowledge about the practices, methods and tools:** Actions focus on application of a diverse range of theory applied to practice. Students are encouraged to draw approaches from across all academic disciplines, to blend and explore hybrid, adapted and new methods in a variety of topically relevant settings. The predominant attitudes are fearlessness and experimentation supported by an appropriate assessment strategy. Actors involve tutors playing a dual, insider/outsider role of action research coach and researcher supported by a community of postgraduate researchers.

3, **Knowledge of self:** Actions involve facilitated group and individual reflection structured to consider knowledge development in the three domains. The predominant attitudes are supportive, open and nurturing – there are 'no wrong answers', growth is the overriding aim. Tutors and peers are equally important actors with tutors adopting a facilitator/mentor role and peers engaging in ad-hoc and spontaneous reflection.

9.0 CONCLUSIONS

Compiling this submission has allowed the author to construct a study that situates his unique contributions within the context of foundational principles supported by authoritative voices and a dynamic curriculum informed by the changing circumstances of external partners [7] and the expanding field of design. Figure 7 highlights the situation of those contributions (circled in red).

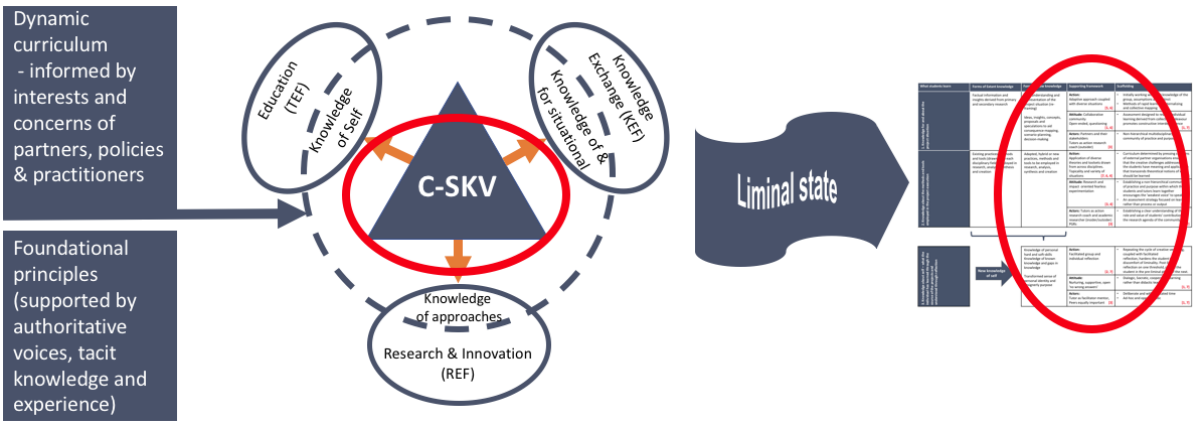

Figure 7. Unique contributions highlighted within the scope of this study

The study started with the notion that understanding knowledge-creation at disciplinary boundaries was important in order to advance the field of design-led multidisciplinary innovation education and to facilitate platforms for innovation for partnering organisations. What the study has revealed is of greater individual importance to the learner and the community within which they operate. A review of the praxis described within the body of knowledge revealed a form of design, which the author has termed 'Co-speculative Knowledge Venturing'. This has been shown to support knowledge-creation for and about the project

situation, for the practices methods and tools of the discipline(s) and of self as multidisciplinary teams navigate individual and collective liminality.

Engaging in C-SKV has been seen to be transformative for individuals who develop a creative confidence that equips them to address unknown and uncertain situations irrespective of their native disciplinary up-bringing or any designerly capabilities which they may, or may not, have previously possessed. Co-created speculative arrangements of different aspects of knowledge pertinent to a situation allow students to consider the situation from multiple different viewpoints and to venture multiple opportunities as possible responses. These responses act as temporal probes that help the group to filter the various arrangements of knowledge until the most desirable one to fit the circumstances is determined.

The speculative application of co-created knowledge in the form of temporal certainties within a context aids understanding of the situation, whilst reflection on this practice, and multiple repetitions of it in different situations, allows the individual to develop personal understanding and meaning relating to their practice. It is important to acknowledge that not all projects create new knowledge within all three knowledge domains but it could be argued that all contribute to new knowledge of self for the individual student.

Threshold Concept theory is a useful lens through which to view the practice of the multidisciplinary team and their co-speculative creative practice. Whilst this theory recognises the variability of students' prior experience and learning within a given subject, and highlights the role of integrative thinking in allowing the student to pass through the given knowledge portal, its application within the multidisciplinary context is less well understood.

The author proposes the term Liminal Learning Lab to describe this type of multidisciplinary practicum within which students, academics, researchers, and external project partners, all adopt the vulnerability of the creative learner in pursuit of new knowledge developed in diverse 'real-world' situations. In this circumstance, they all adopt a state of toggling between liminal and post-liminal understanding. A state of liminality, particularly a repeated or prolonged period in the state, can be deeply unsettling and, potentially, disabling without appropriate support in place. The framework proposed in this study (Figure 6) represents a step towards this support. The addition of suitably contextualised scaffolding elements appropriate to the focus of learning within the particular multidisciplinary setting is an important further step. Figure 8 demonstrates what this looks like for MDI.

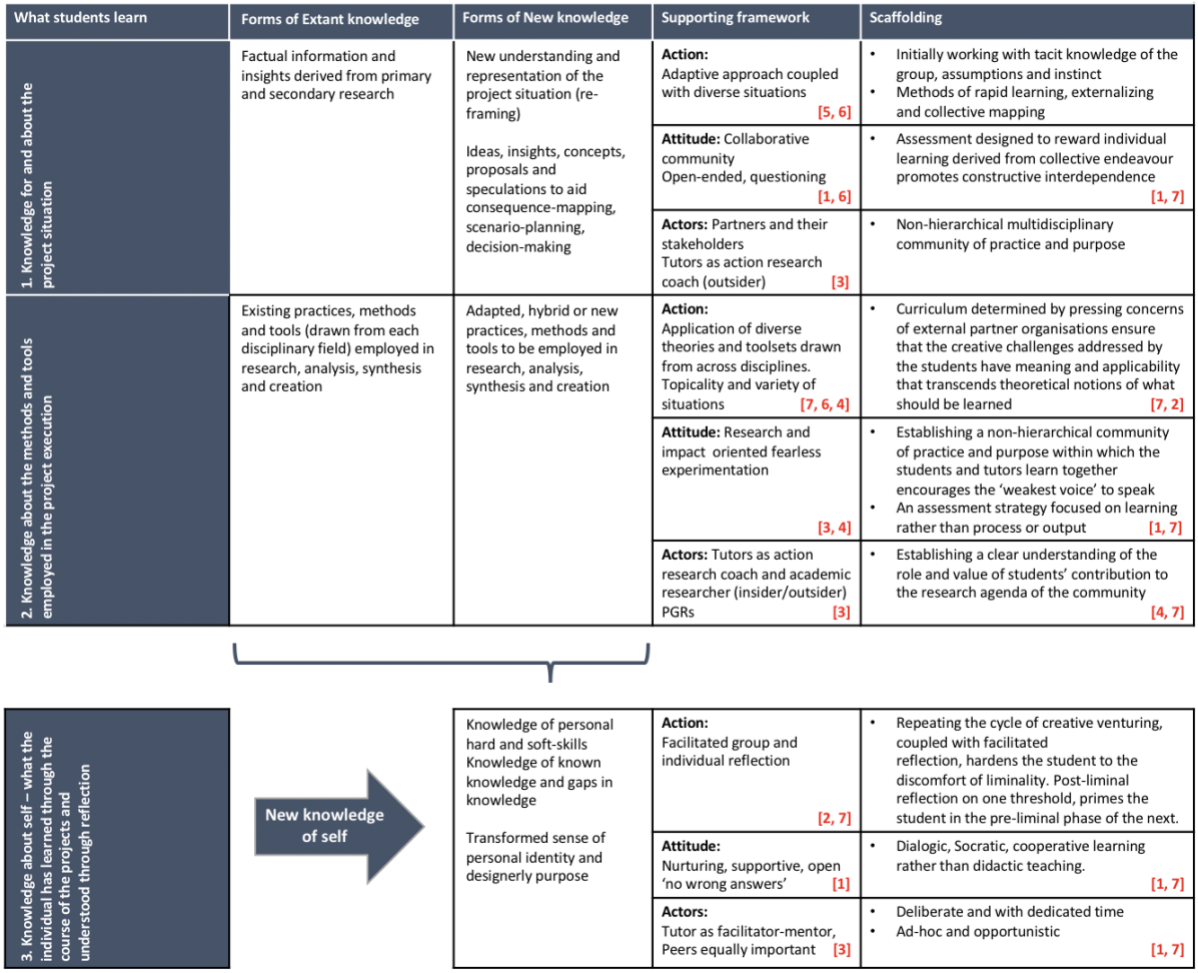

Figure 8. Scaffolded Framework in support of Liminal Learning Lab
(Author's original publications cross-referred in red text)

Whilst the Liminal Learning Lab framework as a whole represents a deliberate and formalised structuring through which students can be guided and supported, certain scaffolding elements highlight additional contributions to knowledge encapsulated within it.

For example, the scaffolding element 'curriculum determined by the pressing needs and concerns of partners' provides a platform for alumni to 'return' to the programme as project partners themselves. The role of alumni in the community of practice is instrumental in supporting student learning. The most influential example of this is in the Innovator in Residence (IiR) scheme [3, 6 and 7] which the author created, whereby selected MDI graduates are invited to take on a paid, fixed-term role supporting the community of practice and its interface with external partners. Further, alumni have played an important role in programme developments, contributing through formal surveys [7], informal data-capture at reunion events and open curriculum development discussions.

Another example relates to the relationship between formative feedback and assessment; 'assessment designed to reward individual learning derived from collective endeavour...'. Indeed, this speaks to the dialogic, Socratic nature of MDI pedagogy in which each studio engagement is a form of 'Crit', but is not critical. The nature of this engagement is important. The typical design crit is described by Schrand and Eliason (2012, p.52) as a form of review in a 'very public setting' in which 'design students explain their projects, answer questions and challenges from the faculty members and guests, and receive their feedback' in front of their

peers. Over time, design students learn to cope with, and eventually 'approach the final critique as a game' (ibid., p.55). This type of public critique is coming under increasing scrutiny as the mental wellbeing of students is increasingly, and correctly, prioritised. For postgraduate students joining MDI from a different disciplinary upbringing constituting different signature pedagogies, mores and behaviours, such a crit would be overwhelming. Hence the approach adopted which, whilst like the crit may comprise elements of presentation within and to the group, places greater emphasis on nurturing fragile ideas in order to support naïve creative enquiry. Students are encouraged to take risks, safe in the knowledge that they will be assessed on their reflection on learning through a portfolio of practice and not on whether the project 'succeeds' or 'fails'. With the emphasis on knowledge-creation, final presentations to project partners are often delivered as workshops designed to interrogate, evaluate and validate the new knowledge emerging from the project.

The end-game of Co-speculative Knowledge Venturing is not the knowledge created (although this is enlightening and of potential value to the partnering organisation [4]), nor the understanding of how to apply it in the given situation (although this is potentially useful [5 & 6]), neither is understanding of how to work collaboratively in creating it (although this is also useful [3]). Rather, it is the meaning that each participating individual takes from its creation. Over time, with facilitated reflection, this meaning helps the individual to establish the role that they can play through employing their knowledge, skills and creative confidence in shaping a better future. The author terms this 'Designerly Purpose' [2].

9.1 Further Research

The knowledge revealed as existing within this body of work has implications for pedagogic developments both within the expanded field of multidisciplinary design education and, potentially, other fields of multidisciplinary education. The author is delivering a new MDI-based post-graduate programme in Armenia and working towards the same in South East and Southern Asia. These ventures offer opportunity to embed the framework and establish the programmes as further research sites within which to test and evaluate and refine the framework within different sociocultural and economic contexts. Additionally, the author will continue this work within MDI at Northumbria University.

Specific plans:

1, The author has established an assessment strategy for students taking the certificate programme at the American University of Armenia that will enable him to evaluate and report on the ways in which students recognise knowledge creation in the three domains of knowledge for and of the situation, for practices, methods and tools and of self.

2, He is employing the Liminal Learning Lab principles and practices in the design of rapid design-led interventions being deployed in programmes such as Creative Fuse North East (http://www.creativefusene.org.uk/) in order to evaluate which of these translate effectively to such intense situations.

3, He plans to work with MDI students to refine and make more student-facing the concept of C-SKV.

4, He will use the Liminal Learning Lab framework as an evaluative tool to research with students the detail of how they understand and navigate liminality as individuals in a multidisciplinary setting and as teams made up of individuals with different disciplinary,

cultural and pedagogic upbringings. This knowledge will be especially beneficial in pedagogic innovation where inter- and multi-disciplinary study is developed.

Finally, the author speculates that there may be one or more threshold capabilities of 'MDI-ness' that draw together combined formal group-learning and Schön's (1987, p.38) "more diffuse process of *background learning"*, with the associated conceptual leapfrogging that the diverse disciplinary upbringings of the group enable as they reach multidisciplinary maturity. He is keen to explore this potential with MDI students and academic colleagues.

10.0 REFERENCES

Alexander, C. (1964) *Notes on the Synthesis of Form* (Vol. 5). Cambridge MA: Harvard University Press.

Archer, B., Baynes, K., Langdon, R. and Roberts, P.H., Royal College of Art (Great Britain) (1979) *Design in General Education: The Report of an Enquiry Conducted by the Royal College of Art for the Secretary of State for Education and Science*. London: Royal College of Art.

Baer, M., Oldham, G.R., Jacobsohn, G.C. and Hollingshead, A.B. (2008) 'The personality composition of teams and creativity: The moderating role of team creative confidence', *The Journal of Creative Behavior*, 42(4), pp. 255-282.

Baillie, C., Bowden, J.A. and Meyer, J.H. (2013) 'Threshold capabilities: threshold concepts and knowledge capability linked through variation theory', *Higher Education*, 65(2), pp. 227-246.

Baker III, F.W. and Moukhliss, S. (2020) 'Concretising Design Thinking: A Content Analysis of Systematic and Extended Literature Reviews on Design Thinking and Human-Centred Design', *Review of Education*, 8(1), pp. 305-333.

Bandura, A. and Jourden, F. (1991) 'Self-regulatory mechanisms for governing the impact of social comparison on complex decision making', *Journal of Personality and Social Psychology*, 60(6), pp. 941-951.

Berger, J.G., (2004) 'Dancing on the threshold of meaning: Recognizing and understanding the growing edge', *Journal of Transformative Education*, 2(4), pp. 336-351.

Bruffee, K.A. (1995) 'Sharing our toys: Cooperative learning versus collaborative learning', *Change: The Magazine of Higher Learning*, 27(1), pp.12-18.

Buchanan, R. (1992) 'Wicked problems in design thinking', *Design issues*, 8(2), pp.5-21.

Centre for the Use of Research and Evidence in Education (2018) *Carl Rogers and the Classroom Environment*, CUREE, viewed 16 June 2021, http://www.curee.co.uk/node/4831

Cox, G. (2005) *Cox review of creativity in business: building on the UK's strengths*. London: TSO.

Cross, N. (1982) 'Designerly ways of knowing', *Design studies*, 3(4), pp. 221-227.

Davidson, N. and Major, C.H. (2014) 'Boundary crossings: Cooperative learning, collaborative learning, and problem-based learning', *Journal on excellence in college teaching*, 25(3&4), pp. 7-55.

De Bono, E. (2015) *Serious Creativity: How to be creative under pressure and turn ideas into action*. Manhattan: Random House.

Design Council (2010). *Multi-disciplinary design education in the UK.* Available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/multi-disciplinary-design-education.pdf (Accessed: 1 February 2021)

Donovan, M. S., Bransford, J. D., and Pellegrino, J. W. (Eds.). (1999). *How people learn: Bridging research and practice.* Washington, DC: National Academy Press.

Dorst, K. (2004) 'The Problem of Design Problems'. *Design Thinking Research Symposium 6, 4 (Creativity and Cognition Studio Press),* pp.135–147.

Dorst, K. (2015) 'Frame Creation and Design in the Expanded Field', *The Journal of Design, Economics, and Innovation,* 1(1), pp. 22-33.

Dorst, K. (2015) *Frame innovation: Create new thinking by design*. Massachusetts: MIT press.

Dorst, K. and Cross, N. (2001) 'Creativity in the Design Process: Co-Evolution of Problem–Solution', *Design Studies* 22(5), pp. 425-437.

Fink, J.E. and Inkelas, K.K. (2015) A history of learning communities within American higher education. *New Directions for Student Services, 2015* (149), pp.5-15.

Flyvbjerg, B. (2011) 'Case study', In N. K. Denzin and Y. S. Lincoln (eds), *The Sage Handbook of Qualitative Research*, 4th ed., Thousand Oaks: Sage, pp. 301–16.

Fosnot. C.T. (1996) *Constructivism: Theory, perspectives, and practice*. New York. NY: Teachers College Press

Frayling, C. (1993) 'Research in art and design', *Royal College of Art Research Papers, vol 1, no 1, 1993/4,* pp.1-5.

Friedman, K. (2005). 'The extended design concept', *Humanities Magazine*, (3), pp. 4-7.

Greenwood, L. and Levin, M. (2007) *An Epistemological Foundation for Action Research: Introduction to Action Research. Introduction to Action Research.* 2nd edn. Thousand Oaks: Sage.

Jen, Natasha (2017) *Design Thinking is Bullsh*t.* Available at: https://99u.adobe.com/videos/55967/natashajen-design-thinking-is-bullshit (Accessed 27 October 2020).

Jenkins, D.M. (2012) Exploring Signature Pedagogies in Undergraduate Leadership Education. *Journal of Leadership Education*, *11*(1).

Johnson, D. W., and Johnson, R. T. (1994) 'Structuring academic controversy', In S. Sharan (ed.), *Handbook of cooperative learning methods.* Westport, CT: Greenwood Press, pp. 66-81.

Jones, C. (2019) A signature pedagogy for entrepreneurship education. *Journal of Small Business and Enterprise Development,* 26 (2), pp. 243-254.

Jones, C., Penaluna, K. and Penaluna, A. (2019) The promise of andragogy, heutagogy and academagogy to enterprise and entrepreneurship education pedagogy. *Education+ Training*, 61 (9), pp. 1170-1186.

Kelley, T. and Kelley, D. (2013) *Creative confidence: Unleashing the creative potential within us all*. Redfern: Currency.

Kemmis, S., McTaggart, R. and Nixon, R. (2013) *The action research planner: Doing critical participatory action research*. Berlin: Springer Science & Business Media.

Kimbell, L. (2011) 'Rethinking design thinking: Part I', *Design and Culture*, *3*(3), pp.285-306.

Kolb, D.A. and Fry, R. (1975) 'Toward an applied theory of experiential learning', In C. Cooper (ed.), *Theories of group processes.* New York: Wiley, pp.33-56.

Kolko, J. (2010) 'Abductive Thinking and Sensemaking: The Drivers of Design Synthesis', *Design issues*, *26*(1), pp.15-28.

Lam, B., Phillips, M., Kelemen, M., Zamenopoulos, T., Moffat, S. and de Sousa, S. (2018) 'Design and creative methods as a practice of liminality in community-academic research projects', *The Design Journal*, *21*(4), pp.605-624.

Lave, J., & Wenger, E. (1991) *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press. Cambridge, England.

Leerberg, M. (2009) 'Design in the Expanded Field: Rethinking Contemporary Design'. *Nordes:* No3 – *Engaging Artifacts.* The Oslo School of Architecture and Design, Norway. August 30 – September 1.

Lexico (2020) Available at: https://www.lexico.com/ (Accessed 27 October 2020).

Martin, R.L. (2009) *The design of business: Why design thinking is the next competitive advantage*. Boston: Harvard Business Press.

Meyer, J.H. and Land, R. (2005) 'Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning', *Higher education*, *49*(3), pp. 373-388.

Mezirow, J. (1997) Transformative learning: Theory to practice. *New directions for adult and continuing education, 1997* (74), pp.5-12.

Osmond, J. and Turner, A. (2010) 'The threshold concept journey in design: From identity to application' In R. Land, J.H.F Meyer and C. Baillie (eds.) *Threshold concepts and transformational learning.* Rotterdam: Sense Publishers, pp. 347-363.

Osmond, J., Bull, K. and Tovey, M. (2009) 'Threshold concepts and the transport and product design curriculum: reports of research in progress', *Art, Design & Communication in Higher Education*, 8(2), pp.169-175.

Phelan, S. and Young, A.M. (2003) 'Understanding creativity in the workplace: An examination of individual styles and training in relation to creative confidence and creative self-leadership', *The Journal of Creative Behavior*, *37*(4), pp. 266-281.

Rauth, I., Köppen, E., Jobst, B. and Meinel, C. (2010) 'Design thinking: An educational model towards creative confidence', In T.Taura and Y. Nagai (eds.) *DS 66-2: Proceedings of the 1st international conference on design creativity (ICDC 2010)*. The Design Society.

Rittel, H.W. and Webber, M.M. (1973) 'Dilemmas in a general theory of planning', *Policy sciences*, *4*(2), pp.155-169.

Robson, C. (2002) *Real world research: A resource for social scientists and practitioner-researchers.* Vol. 2. Oxford: Blackwell.

Rowe, P.G. (1987) *Design Thinking.* Cambridge, MA: MIT Press.

Sanders, E.B.N. (2002) 'From user-centered to participatory design approaches', in J. Frascara (Ed.) *Design and the social sciences,* Taylor & Francis Books Ltd., Florida, USA, pp. 18-25.

Schön, D.A. (1987) *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions,* San Francisco: Jossey-Bass.

Schrand, T. and Eliason, J. (2012) Feedback practices and signature pedagogies: what can the liberal arts learn from the design critique? *Teaching in Higher Education*, *17*(1), pp.51-62.

Shreeve, A. (2015) 'Signature Pedagogies in Design', in M Tovey (ed), *Design Pedagogy: Developments in art and design education.* Routledge, London, pp. 83-94.

Shulman, L.S. (2005) Signature pedagogies in the professions. *Daedalus*, *134*(3), pp.52-59.

Simon, H.A. (1969) *The sciences of the artificial*, Cambridge M.A.: MIT Press.

Sinek, S. (2009) *Start with why: How great leaders inspire everyone to take action*. London: Penguin.

Tovey, M., Woodcock, A., Osmond, J. and McDonagh, D. (2019) 'Empathy Thresholds in Transport Design Students', *Design and Technology Education: an International Journal*, *24*(1), pp. 65-78.

Turner, V. (1967) *The Forest of Symbols: Aspects of Ndembu Ritual.* Ithaca, NY: Cornell University Press.

Ulibarri, N., E Cravens, A., Cornelius, M., Royalty, A. and Svetina Nabergoj, A. (2014) 'Research as design: Developing creative confidence in doctoral students through design thinking', *International Journal of Doctoral Studies, 9*, pp. 249-270.

Van Gennep, A. (1960 [1909*]) The Rites of Passage* (Vizedom MB and Caffee GL, trans.). London: Routledge and Kegan Paul.

Verganti, R. (2009) *Design driven innovation: changing the rules of competition by radically innovating what things mean*. Boston: Harvard Business Press.

Vygotsky, L.S. (1978) *Mind in society*. M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (eds.) Cambridge M.A.: Harvard University Press

Wenger, E. 2015. *Communities of Practice*. *A brief introduction.* Introduction to Communities of Practice, viewed 16 June 2021, https://wenger-trayner.com/introduction-to-communities-of-practice/

Appendix 1: Table of published works

	Published works
1	Bailey, M., and Smith, N. (2010) 'Safe Environments for Innovation-Developing a New Multidisciplinary Masters Programme' in Boks, W. et al (eds.) *DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education - When Design Education and Design Research meet ...* Strathclyde: The Design Society Institution of Engineering Designers, pp. 60–65
2	Bailey, M., Duncan, T. and Aftab, M. (2014) 'New Design is Bigger and Harder-Design Mastery in a Changing World' in Bohemia, E. et al (eds.) *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations.* Strathclyde: The Design Society Institution of Engineering Designers, pp. 443–448
3	Bailey, M. and Smith, N. (2016) 'Making it Work; Integrated Academic Practice' in E. Boya (ed.) *Proceedings of 20th DMI: Academic Design Management Conference; Inflection Point: Design Research Meets Design Practice.* Boston: The Design Management Institute, *pp. 2346–2363*
4 4a	Bailey, M., Spencer, N., Smith, N., Knott, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design-led Innovation Practice' in Marjanović, D. et al (eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781–1792 Also published in translation as: Bailey, M., Spencer, N., Smith, N., Aftab, M., Knott, C., and Sams, P. (2018) Framing Strategic Value por meio de Design-led Innovation Practice. *Project Design Management*, 16 (82). pp. 54-63.
5	Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018).* Loughborough: DRS, pp. 538–545
6	Bailey, M., Chatzakis, E., Spencer, N., Lampitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127. doi: 10.1386/dbs.5.1.95_1
7	Bailey, M. and Spencer, N. (2019) 'The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum', *The International Journal of Design Education*, 13 (4), pp. 89–109. doi:10.18848/2325-128X/CGP/v13i04/89-109.

APPENDIX 2: Publications

Publication 1

Safe Environments for Innovation – Developing a New Multidisciplinary Masters Programme

This double-blind, peer reviewed conference paper, published as a chapter in the proceedings of the 12th International Conference on Engineering and Product Design Education: When Design Education and Design Research Meet (2010), sets out the background and design process behind the creation of the MA/MSc Multidisciplinary Design Innovation programme at Northumbria University. It summarises a pilot study in multidisciplinary learning that the author conducted which established fundamental principles for the subsequent design of the programme which is described in some detail.

The study identifies the importance of attending to

- The physical and mental environment in which creativity can be nurtured
- Establishing a community of practice in which a 'common language' would be learned
- Promoting shared values through developing self-awareness in pursuit of collaborative learning

Within the context of this PhD submission, the importance of establishing a multidisciplinary community of practice which is supportive of the different disciplinary backgrounds of students is of particular importance. This has proven to be essential to providing a safe environment that promotes experimentation and the associated uncertainty that goes with it.

INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
2 & 3 SEPTEMBER 2010, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, TRONDHEIM, NORWAY

SAFE ENVIRONMENTS FOR INNOVATION - DEVELOPING A NEW MULTIDISCIPLINARY MASTERS PROGRAMME

Mark BAILEY and Neil SMITH
Northumbria University, UK

ABSTRACT
This paper outlines the research and resulting curriculum design activities conducted as a collaborative venture between Northumbria University's School of Design, School of Computing, Engineering and Information Sciences and Newcastle Business School undertaken in the creation of a new post-graduate programme in Multidisciplinary Design Innovation.
With the area of multidisciplinary innovation education practice being comparatively new, the research conducted in support of the programme development was undertaken through a series of industry-linked pilot-study projects conducted with Philips, Hasbro, Lego and Unilever. The key finding from this research was an understanding of the importance of freeing students from different disciplines of the inhibitions that limit creativity in collaborative settings.
This paper gives an account of the pilot studies and the associated learning derived from them, the collaborative development of the programme and approaches in curriculum and assessment design adopted in order to create what we call 'safe environments for innovation'; environments designed to free students of these evident inhibitions.

Keywords: Multidisciplinary, innovation, design-thinking, collaboration, team-work

1 INTRODUCTION

In September 2007, three schools at Northumbria University came together in collaboration to create a Masters Programme in Multidisciplinary Design Innovation. The lead school was the School of Design (SoD) working together with the School of Computing, Engineering and Information Sciences (CEIS) along with Newcastle Business School (NBS). This innovation was both in response to an emerging understanding within the School of Design of the value of 'Design-Thinking' as a multi-disciplinary activity, developed and reinforced through a series of under-graduate pilot projects, and the Cox Review of Creativity in Business: building on the UK's strengths, which was commissioned by the, then, Chancellor of the Exchequer, Gordon Brown at the time of the 2005 Budget. (Design-Thinking is an approach to viewing business and organisational situations from a more interpretative perspective than that of traditional business analysis (Lester, Piore and Malek, 1998)). The programme was launched in September 2008.
Design-Thinking has been shown, most visibly through the work of commercial agencies such as IDEO, to lead to more creative and effective solutions both in organisational structure and strategy as well as new product and service development. To be truly effective, it relies on collaboration between activists with specialist knowledge of, typically, but not exclusively, design, engineering technology and business who are comfortable working with, and have an understanding of, complimentary disciplines. Such individuals have been described as 'T-shaped' (Leonard-Barton,1995) - they have deep knowledge of one subject (the down-stroke of the 'T') and broad experience and understanding of other disciplines (the cross-stroke). Tim Brown, CEO of IDEO and Visiting Professor at Northumbria University states that T-shaped individuals are *'not to be confused with a 'Jack of all trades' T-shaped people have a core competency, but can easily branch out. And they possess curiosity, empathy and aren't afraid to ask why'* (Brown, 2007)

Creating a successful learning environment in which students feel safe to ask 'why?' and to 'branch out' required an understanding of the potential impediments to engagement and the supporting curriculum necessary to develop the characteristics of learners as T-shaped individuals. The Pilot Projects were designed to allow staff from each discipline to observe and identify these impediments. Advocacy for this creative approach isn't restricted to designers however. In his lecture 'Real Engineering', Prof Fred Maillerdet, Visiting Professor of Engineering Pedagogy, explained the need to return to creativity and innovation as fundamentals in undergraduate engineering programmes (Maillerdet, 2009). Similarly, Roger Martin, Dean of the Rotman School of Management in Toronto proclaims the value of Design-Thinking as an essential leadership approach, "*The designers who can solve the most wicked problems do it through collaborative, integrative thinking, using* abductive *logic, which means the logic of what might be.[]I saw that this was what great business leaders do"*(Dunne; Martin. 2006)

2 PILOT PROJECTS

Four pilot projects were conducted during 2006 and 2007 with a mixed-discipline cohort of undergraduate students and in collaboration with Lego, Hasbro, Philips and Unilever. They were run outside curricular time as un-graded placement projects. The projects ranged from fairly straightforward incremental development of products within a defined range to more radical and disruptive innovation; seeking to influence the way that scientists approach problems through the production of media designed to inspire creativity. The students worked as a team on each project with academic support and direct client contact. The projects were observed by academics from each of the three disciplines and whilst design praxis may be the obvious home for innovation practices, staff were keen to expose and explore other, equally valid approaches adopted in other disciplines. The projects revealed three key insights. The most significant, relating to the confidence levels of the individuals, involved expressing themselves and their disciplinary expertise on an equal footing to others or to question that of their colleagues. Also significant was the potential for misunderstanding to arise resulting from the specificity of meaning attributed to key terminology as it related to the different disciplines. The third observation was the challenge of dealing with the inherent ambiguity in projects with a more disruptive intention; these projects, where the scope of exploration is less clearly defined were more readily embraced by the designers who had greater experience of venturing into the unknown in their work. Students commented that their confidence grew as their clients offered critical support to the work and they were 'given permission' to adopt a more explorative approach without fear of failure; the work was not assessed.

3 DESIGNING THE PROGRAMME

Based upon three guiding principles derived from the Pilot Projects, a group of senior academics from the three separate schools started meeting to discuss the potential to develop a new Masters programme in the field of Design-Thinking. These principles were:

- To create a physical and mental environment in which creativity would be nurtured
- To develop a community of practice in which a 'common language' would be learned
- To promote shared values through developing self-awareness in pursuit of collaborative learning

Several meetings were conducted before any clear direction or structure was identified. In hindsight, perhaps what was happening was an orientation and alignment process through which each individual was making sense of the overall programme objectives and once they had contextualised it from the point of view of their own discipline, attempting to find a language of expression which was congruent within the group. This, in itself, was an indication of the likely behaviour that could be expected within a multidisciplinary cohort, and coincided with observations made during the pilot projects.

In order to move the programme forward, the activists in the development team had to behave as 'T-shaped' individuals themselves. This involved acknowledging the value that each discipline would bring to the programme and separating this from the differentness in the pedagogic, structural and administrative approach of each school. It was clear that teachers would be learning alongside students!

4 THE DESIGNED STRUCTURE

The programme is designed to have three semesters delivered on–campus over one year. It involves a multi-disciplinary cohort of students working under the guidance and teaching of a multi-disciplinary team of academic staff, each with expertise in their own field. It is a truly collegiate venture planned around unique ways of working in which the staff teams collaborate to debate and discuss students' emerging ideas in cross-disciplinary plenary sessions.

Much as the development team needs to understand the contextual relevance of each discipline relative to the others, so do the students of the MDI programme. To this end, students take contextual modules in the complementary subjects; 'Understanding the Business Context, Understanding the Technology Context' etc. (see Figure 1). These run through the first two semesters and make the connection between theory and practice, increasingly exposing students to the language and practices of the host discipline.

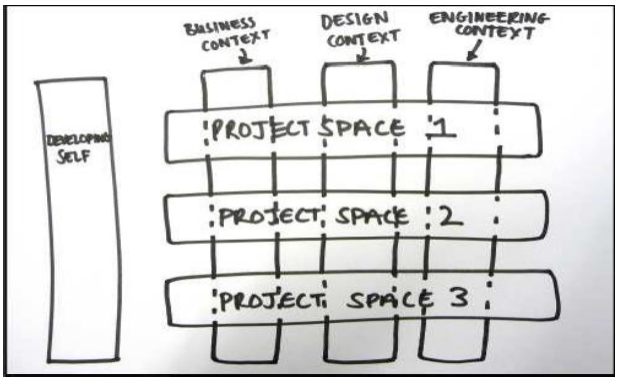

Figure 1. An original concept sketch for the programme structure

Problem based learning is fostered through three, semester-long modules, involving Familiarisation Projects (Semester 1), Experimentation Projects (Semester 2) and Integration Projects (Semester 3), through which students working in multidisciplinary teams explore problem and solution spaces. These are large modules allowing staff and students freedom to explore collaboratively. As they progress through the semesters, the client-voice in their projects increases in volume; in the first semester as they learn to work together, projects tend to be internal, in the second they work as teams but with one external client to the whole cohort whilst in the third, each team of three or four students has a client to manage themselves. This approach addresses key observations from the pilot studies; students are initially given a 'safe environment' in which to orientate themselves to the demands of multidisciplinary working and to develop the self-awareness necessary to separate self from team. As their awareness develops, so does the role of the client in their work until, in the final semester, they are able to focus much more on the project than team-behaviour.

From the outset, it was the expectation that students would work outside their comfort-zone and in support of this, the programme has adopted a strong self-reflexive approach (Schon, 1987) where students engage in a two semester module 'Understanding the Interdisciplinary Self' that allows them to relate their project-based experiences to a theoretical framework so that they may understand where they fit in and how they can contribute to the multidisciplinary team. This strand feeds into their final semester Design-Thinking Thesis in which they explore and define this position.

In a session addressing the question "What are the barriers to multidisciplinary teams achieving success?" Prof Steven Kyffin supports the argument for self-awareness. He identifies three issues; Personal – those personal agenda items that individuals bring to any team situation, Institutional – the agenda defined by the organisation, and Disciplinary – the collective confidence derived from familiar methods adopted within a given disciplinary group (Kyffin, 2009). In the MDI students' experience, the 'Personal' and 'Disciplinary' are addressed by the Interdisciplinary Self and Project modules respectively. In this academic context, the 'Institutional' is represented by the curricular and assessment structures needed to measure and support academic attainment. In the industrial setting these would be measured in commercial terms.

5 SAFE ENVIRONMENT

In order for true creativity to flourish, participants need to operate free from inhibition and confident that their contribution will be valued. Through committed engagement in creative, explorative and reflexive activities deep learning is achieved and new opportunities can be discovered. Essential to ensuring this is the establishment of a community where understanding is nurtured and freedom to create is celebrated. The programme is built upon recognition that it must support the potential for what Toni Matti Karajleinen refers to as "creative abrasion" through which a deeper understanding is achieved. (Karajleinen, Salimäki 2008)

Both the physical, mental and curricular environments have been considered in ensuring that the programme nurtures this fundamental pursuit of collaborative creativity.

The programme is delivered in a unique space tailored to support learning in a collaborative community based on flexible 'project spaces' and formal and informal exchange environments. (Bailey, 2000). Through the project and informal exchange spaces students are actively encouraged to expose and share their ideas through use of image, text, photography and so forth. A more formal 'boardroom' is employed to bring professionalism to client presentations and project meetings. The design of this physical environment is key to supporting the community of practice essential in encouraging the confidence to participate and share. Equally important in this respect is the confidence that industrial partners feel in engaging in this space. This is achieved by providing a secure environment where projects can be openly displayed as works-in-progress and the space is used to mediate the activity between client and students. An example of this is a recent project undertaken with the BBC where students created 'Radio Stations' (genre-based listening environments) in which to expose and explore aspects of listener experience in a way that made this explicit to the client.

Mentally liberating the students to explore the new approaches and methods of complimentary disciplines requires re-thinking the way in which students are assessed in order that they are encouraged to strive for more than simply safe solutions. In this pursuit, assessment for learning needs to take a supportive role. The development of self-awareness and confidence that the first two semesters promote is supported by these projects being un-graded. Using the self-reflexive approach students become aware of the strength of their contributions and where they can afford to take risks in pursuit of the project objective and how to take best advantage of collaboration. This approach is supported across many disciplines, for example in mathematics where Winkel states *"the formative assessment takes place in the interaction among students and between students and teacher. Basically, the students "expose" their unshaped ideas and strategies, get feedback from classmates on their ideas, hone their articulation, and reject false notions. In so doing they clarify and move to a higher level of development. Observing and interacting with students who are going through this problem-solving process is an excellent way for the teacher to assess what students really understand."* (Winkel, Brian, 2006).

Essential is that the academic structure is supportive enough to encourage this 'exposure', particularly in the early days of the cohort forming. Assessment is not, therefore, of project outcomes, but of the individuals' learning derived from the various project and team activities undertaken through the modules. This is presented in a 'Portfolio of Practice' as a factual account of what took place and a personal reflection of the consequent learning. Client organisations understand that projects undertaken in the second semester are likely to reveal as much about multidisciplinary innovation as they are about the topic of the brief and appreciate the value of this in relation to developing their own experience in this area.

A similar portfolio approach is adopted in the 3rd Semester Integration Projects at which stage students have largely overcome the team working challenges and are confident to focus on collaborative innovation practice in service of the project rather than themselves.

6 COMMON LANGUAGE

Establishing an equality of voice is essential to establishing equality of value (and confidence) within the group. From a disciplinary perspective, this necessitates the promotion of honesty in acknowledging what I don't know as much as what I do. Human nature dictates that in a group situation, we tend to avoid asking the 'dumb question'. To this end, we have established our 'Wall of

Words' upon which students (and staff) are encouraged to write-up the terms and phrases, acronyms and methods that are unfamiliar to them. Peers are required to explain these (see Figure 3). Seeking a common language as disciplines emerge is necessary to effective working (Kimbell, Siedel, 2008; Boland, Collopy, 2004) and as equality is established, students can start to identify true collaborative value. One student commented at the end of a recent project;
"The group provided another effective result by letting all of the disciplines have a say, we incorporated each other's criticisms and ultimately created three concepts that all originated from different group members. The innovation we each saw here was that no-matter what the idea; each member added something to it to turn out the concepts."

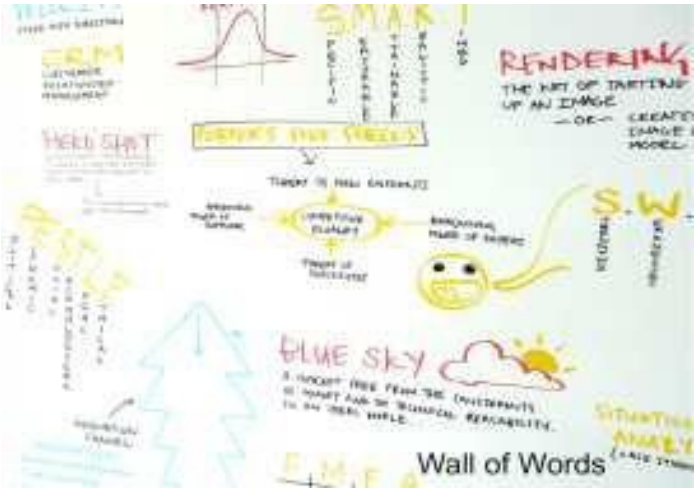

Figure 2. 'Wall of Words'

Gen Doy, explains that students and researchers who move from one discipline to another "*encounter languages and cultures which may seem alien, or perhaps welcoming. They feel uncertain and lacking in confidence sometimes, because they do not feel "at home" in the new discipline...".* (Doy, 2008) As we gain a greater understanding of each others' language and refine our prototype we will not only learn a common language, but will develop a common vernacular for multidisciplinary innovation practice that will become our 'at home'.

7 SHARED VALUES

We have shown how this new programme has been developed from sound principles and direct observation of multidisciplinary innovation practice in action. To date, students have worked successfully with such organisations as The MS Society, BBC, Mars, Unilever, Berghaus and Sonoco Alcore as well as a host of regional SMEs. Fundamental to sustaining this success is the honesty and commitment of stakeholders learning how to communicate and work together. We need to look to our students as partners in this research. We give them the last words as they explain through their Terms of Engagement (Fig. 4) the factors that they believe are essential to support their multidisciplinary innovation practice.

Figure 3. Terms of Engagement

These shared values are displayed within their project spaces as a point of reference at moments when tensions run high or project directions are lost. When this happens in a team, or "creative abrasion" ceases to be productive, students are encouraged to "give the problem to the wall".

8 CONCLUSION

The MDI programme's pilot projects and first year of operation demonstrate the fundamental importance of supporting the growth of the individual by providing an open and reflexive framework within which they are given permission (by a liberating assessment strategy) to behave in an experimental, explorative way. However, creating an open framework, without that supportive structure of the self-reflexive element and structured academic support, would have created a risky environment for students. The pilot studies clearly indicated the need to develop the confidence of the individual so that they may participate fully in the group.

Similarly, creating a framework without a place in which to participate would make it very difficult to establish a dynamic community of practice, developing a common language and in pursuit of shared learning. The creation of a neutral, non-territorial physical environment has been fundamental to the success of the venture in this respect.

In order to explore fully the potential of multidisciplinary innovation, students need to feel secure that they can be rewarded for 'brave failure' in pursuit of new understanding and that they can explore the boundaries supported by safe environments.

What we have learned here is applicable in any situation where group-based collaborative learning is appropriate. In understanding the dynamics of multidisciplinary working, there is clearly much to be done to unpick the complex interplay of personal, disciplinary and institutional dimensions that contribute to individuals' behaviour. Through the reflexive nature of our programme, we believe that we have a suitable vehicle for exploring this further enlisting our students as co-researchers.

REFERENCES

[1] Bailey Mark, 2000. The challenge of being through doing in design education. Re-inventing Design Education in the University. Curtin Print & Design

[2] Boland Richard J, Collopy Fred, 2004. Managing as Designing. Stanford University Press

[3] Brown Tim, 2007 InterSections, Newcastle: Northumbria University October 2007, Design Council, Available at: http://www.designcouncil.org.uk/en/Design-Council/1/What-we-do/Our-activities/Intersections-07/

[4] Cox Sir George, 2005. Cox Review of Creativity in Business: building on the UK's strengths, HM Treasury

[5] Doy Gen, 2008 Interrogations, Leicester, DeMontford University January 2008, Available at: http://www.interrogations.org.uk/papers.htm

[6] Dunne David, Martin Roger, 2006. Design thinking and How it Will Change Management Education: An Interview and Discussion, Academy of management Learning and Education, 2006, Vol5, No 4, p 512 - 523

[7] Karjalainen Toni-Matti, Salimäki Markku, 2008. Do offerings meet expectations? Proceedings from International DMI Education Conference Design Thinking: New Challenges for Designers, Managers and Organizations, ESSEC Business School, Cergy-Pointoise, France, Available at: http://www.dmi.org/dmi/html/conference/academic08/papers/Karjalainen/DMI%202008%20TMK&MS%20Final.pdf

[8] Kimbell Lucy, Seidel Victor P, 2008. Designing for Services - Multidisciplinary Perspectives: Proceedings from the Exploratory Project on Designing for Services in Science and Technology-based Enterprises, Saïd Business School, Oxford.

[9] Kyffin Steven, Bailey Mark, Watson George, 2009. Reveal 2009, Newcastle. Available at http://www.northumbria.ac.uk/static/worddocuments/desdocs/StevenKyffinDebate.doc

[10] Lester, Richard K, Piore, Michael J and Malek Kamal M, 1998. "Interpretive Management: What General Managers Can Learn From Design, March – April 1998. P88

[11] Schon, Donald, 1987. Educating the Reflective Practitioner. San Fransisco, Jossey-Bass.

[12] Winkel, Brian J, 2006. Formative Assessment During Complex, Problem-Solving, Group Work in Class, The Mathematical Association of America

Publication 2

New Design is Bigger and Harder – Design Mastery in a Changing World

This double-blind, peer reviewed conference paper, published as a chapter in the proceedings of the 16th International Conference on Engineering and Product Design Education: Design Education and Human Technology Relations (2014), positions multidisciplinary design education within the context of the changing landscape of design in an expanded field. It develops the concept of '**designerly purpose'** the object to which an individual focuses their designerly capabilities in order to bring about positive change.

Within the context of this PhD submission, the significance of developing designerly purpose is seen as the tangible and useful outcome of developing knowledge of self, the third of the knowledge domains that the study identifies.

NEW DESIGN IS BIGGER AND HARDER – DESIGN MASTERY IN A CHANGING WORLD

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Design-led, transformative innovation, with social or commercial value, is achieved through an increasingly complex and diverse spectrum of contexts requiring a broad range of specialist knowledge and skills. Delivering such innovation is rarely a solo-act. It is collaborative and multidisciplinary. Such innovation capitalises on scientific and technological discovery as well as business know-how and context-specific specialist knowledge all given meaning through design. At its best, it redefines the way we live, the way we create value and the way we craft our future selves. It relies on both individual growth and a willingness and ability to work with others to venture into the unknown.

The traditional models of design mastery, however, focus on the development of advanced level individual knowledge and practice. This paper establishes principles for Post Graduate education in Design Innovation within the context of design's changing and expanding role.

Keywords: Design, Masters, New Mastery, Design-led Innovation, Innovation Design

1 INTRODUCTION

The roles of the designer and the design disciplines have changed over the decades as the practices of design have evolved and the social, cultural and political contexts in which designers have operated have shifted. The likes of McCullagh [9], Gardien & Gilsing [8], Verganti [16] and Yee, Jefferies and Tan [17] have all charted changes in the role and influence of the design function for organisations [2]. The changing nature of design itself has been additive; the development of new tools for designers has arguably meant little reduction in the usefulness of the 'old' tools. Similarly, the changes in territories and context have required acquisition of new knowledge and skills in addition to those that are core to traditional models of design. The new models of design need to address these bigger trends and transformations. The authors reflect on the implication of this on design education and propose ways in which it could respond to this changing landscape.

1.1. Background and methodology

Currently the suite of MA Design programmes at Northumbria University comprises education in design management and design (with specialisms in industrial, fashion, graphic, performance products, service, interior design etc.). Although these programmes provide students with the ability to reflect and apply knowledge in their individual contexts and specialisms, the opportunity exists to better align them to the needs of contemporary design theories and practices. Operating alongside these is a cross-faculty programme in multidisciplinary innovation. Determined from literature, direct engagement with employers and users of design and through an auto-ethnographic and semi-structured interview approach the authors have reflected on these programmes and explored the gaps between what they offer and what masters of design in the future will need.

2 STARTING POINTS

Jonathan Ive is famously quoted as saying *"Design is not important. Good design is important."*

And whilst it is hard to argue with this, it is worth considering what we mean by good design, and whether good design on its own is enough. We are all familiar with good designs that have been commercial flops or failed to deliver the societal benefit that they promised (Microsoft web TV plus; Betamax, Sony; The Newton, Apple; Cocaine, Redux Beverages; eVilla, Sony, and Pippin, Apple/Bandai etc) because they haven't been supported by the appropriate, sustainable business model, manufacturing capability or delivery strategy required to enable them to flourish. Traditionally, design in isolation is seen to provide a service to new product development but today this position of design is being challenged. Recent research in mapping innovation practices in multinationals confirmed *"it is possible to operate as an individual but the complexity of today's issues is making this very difficult for inventors. The concept of a designer working in a garage and making sense of form and function has been transformed into multidisciplinary teams where we see designers working with physiologists, engineers, scientists etc."* (p. 81) [2] Hence, good design alone is of little value.

Berkun [5], defines innovation as delivering 'significant positive change' whilst another popular definition [6], suggests that it is 'bright ideas realised'. Taken together, we can see a role for design in these definitions (through the creation of ideas), but we can also see gaps in what design has to offer in terms of 'change' or 'realization', which rely on a complex interplay of context, specific factors if they are to be achieved. Press & Cooper [12] agree that innovation in new products and new markets is most important for top executives. Therefore, it is unreasonable to expect that designers acting alone, could make a significant contribution in the delivery of change other than in the creation of beautifully resolved ideas. It is even more unlikely that a young designer with only a Bachelors degree, often achieved in isolation from the real-world demands of business, could affect such change.

Press and Cooper (2003, p. 17) [12], state that *"...Design and innovation are complementary, design being a core element of technical or product innovation yet also broader in its influence on product. Innovation is also broader than design in terms of management areas in which it can occur alone. Together design and innovation are in effect the drivers of any successful business".* For design to have relevance in society, its purpose and application must surely be the creation of 'significant positive change'. It follows, therefore, that design education's focus must shift to encompass innovation. We must adjust our focus to Design Innovation. And, we have established that innovation relies upon a mixed discipline collaborative approach; this in turn means that new mastery must promote multidisciplinary cooperation as well as the development of personal, discipline specific expertise.

2.1 Design Innovation Education

Bachelors education for designers is relatively mature, the 'Competency Model' developed and described by TU/e [14] is indicative of that which is covered by many of the more established undergraduate programmes which focus on the development of knowledge, skills and attitude achieved through practice and demonstrated through projects. These are given relevance by the context of application, in the best cases through interaction with real-world situations through 'live' industry-linked projects and internships. These curricula generally have a fairly narrow 'band-width' focusing on specific design disciplines; Industrial Design, Fashion Design etc. In the case of TU/e, this is Industrial Design Technology.

This brings us to the role of post-graduate education in Innovation Design. Typically, the designer who attains mastery in their chosen design subject demonstrates this through their graduating, or dissertation, project; their 'masterpiece'. When the context of application has a narrow bandwidth such mastery is comparatively easy to identify and assess. For example, a master designer of furniture can demonstrate their mastery by value-creation in the production of multiple designs of chair suited to multiple use scenarios exploiting a variety of materials and production methods (Innovation). Through their designs they may express new design processes, knowledge and know-how (Research). The chair will represent a tangible manifestation of their tacit knowledge, demonstrating what they know about how they think with both their head and their hands (Reflection). A challenge for Mastery in Design Innovation is that it requires a broader expression, connectivity with other disciplines, methods, approaches and contexts, making the masterpiece less

readily interpreted.

2.2 The Designer Innovator

As the importance of innovation has increased, so too have the descriptions of the designer as a letter-formed individual; T-shaped, X-shaped, Y-shaped; have all been tried. These descriptions have all acknowledged two things; the increasing need for designers to have the ability to collaborate across disciplines, and the importance of deep, core knowledge. McCullogh [9] in exploring the notion of the T-shaped, identified a need for designers to ensure that they have a strong 'vertical stack' before venturing too far into the domains of others through their horizontal reach (within the educational setting, one could argue that this is the role of a good Bachelor degree in establishing core design competencies). Neumeier [11], whilst acknowledging the important role that 'T's' have to play, extolls the virtues of the 'X-shaped' individuals who connect and lead. Importantly, he stresses the importance of the individual's strengths and the development of their personal, high-level 'meta- skills'; "*Whether a T or an X, you still have to develop your own skills, create your own thought processes, and spend time alone in the "dragon pit" – the space between what is and what could be. In the dragon pit, a master's degree won't help you. Only mastery itself.*"

This lays down a clear challenge to those who run such Masters degrees. Neumeier's [11] focus on 'self' chimes well with Vanderbilt's [15] adoption of Sinek's [13] Golden Circle, 'What, How and Why' model in proposing the 'whY-shaped' individual. He places emphasis clearly on the individual's purpose (or 'Why') in employing their specific skills and knowledge and in establishing the connections that they make. Sinek [13] is clear that we can only lead meaningful change if we (or our organisations) do so with a clear sense of purpose or set of shared values. Similarly, we have seen in our own research [4] that multidisciplinary team success is only achieved once the team establishes a clear, shared purpose and translates this into a vision before embarking on delivering the vision through creative possibilities.

Supporting the development of clear personal purpose as a designer within the constructs of a clear institutional purpose for design innovation education (delivering significant positive change) is a compelling principle upon which to build.

3. Principles for New Mastery in Design

Against this changing landscape then, we have established three clear principles:

- Design on its own is not enough; what the world needs is Design Innovation. Our new mastery needs, therefore, to deliver this.
- We know that innovation is dependent upon individuals combining their knowledge and skills with those of other disciplines and that, in order to do this they must learn about themselves in relation to others; they must learn to collaborate and work in multidisciplinary teams.
- Only design innovators with a clear sense of purpose will bring about meaningful change; our programmes need to focus on developing designerly purpose.

The expanding reach of design theories and practices suggests that we need to be able to develop this mastery across a broad spectrum of design disciplines. This spectrum spans from 'design-thinking' to 'design doing' and recognizes the absolute value of the associated range of knowledge, skills and competencies (and the doing in thinking and thinking in doing!). The expression of that output is given relevance by the context in which it is applied – an authentic application in the 'dragon-pit'.

- Context relevance is the fourth principle upon which programmes of Design Innovation should be founded.

3.1 Designerly Purpose

At the heart of this new mastery are learners and their developing designerly purpose; as an individual, as a member of an organisation and as a member of society. In considering what dimensions contribute to the developing designerly purpose we can look to Adair's 'task-team-

individual' model for Action Centred Leadership [1]. For the individual to develop and understand their purpose as a designer, they need to develop an awareness of their personal values, to test these in context through an established task purpose and to do this in relation to others.

Whilst our individual values may be firmly engrained, our designerly-purpose is not static; it is shaped by our experience and the tacit knowledge we derive from it. Building on Sinek's model, 'How' we express our designerly purpose is important to the development of it through reflective cycles [7] and this is equally relevant whether we are a design-doer, thinker or researcher (or, as is most typical, combination of all three). 'What' we do, establishes the sphere of influence in which our designerly- purpose is manifest. Figure 1 illustrates one such tapestry where the 'why' (purpose), 'how' (design doing/design thinking/design researching) and 'what' (design output) interplays to define the individual value of a designer.

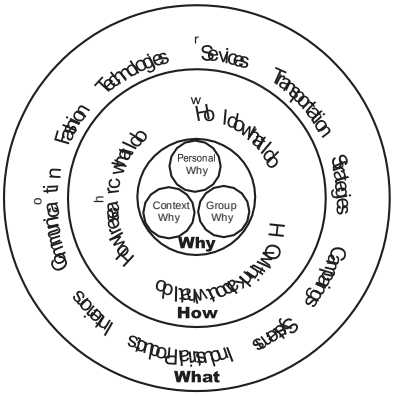

Figure 1: Illustrating value of a designer (Source: Adapted from Sinek (2013))

Acknowledging that our students at Masters level already have their core competencies as designers, what then do they need to learn in order to establish their designerly-purpose and to be able to create a masterpiece suitable of demonstrating the mastery that would satisfy even Neuemier [11] and, more importantly, equip them to affect significant positive change for the betterment of society (our purpose!)?

4 CONCLUSION

The influence of the changing landscape of design has caused us to reflect upon Masters education in design. We have concluded that, in order to nurture graduates who can bring about significant positive change we need to focus on the development of their individual designerly purpose and provide them with the contexts within which to explore and demonstrate their mastery of Design Innovation.
Therefore, we propose the application of the above stated principles and the following key knowledge blocks as required for the delivery of new mastery.

4.1 Key Knowledge for Design Mastery

Simplistically, we can think of Innovation Design mastery existing on a horizontal doing-thinking spectrum where the students (design doers/design researchers/design thinkers) learn with and from each other (Figure 2). The horizontal spectrum provides the context situations through which they develop and demonstrate their mastery.

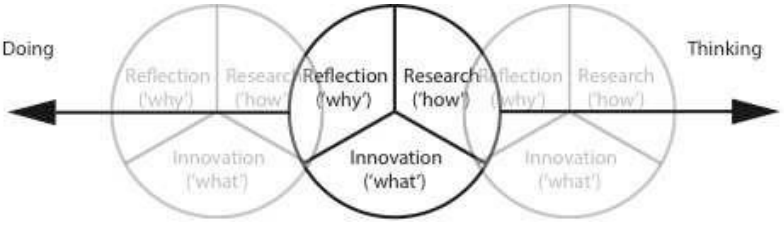

Figure 2: Doing-thinking spectrum

Irrespective of where they position themselves on the doing–thinking spectrum, the three knowledge blocks of Innovation, Research and Reflection will underpin their study and deliver the principles.

1, Reflection will underpin the students' purpose, their 'Why' in relation to themselves, their discipline and their colleagues. It will provide an understanding of themselves in relation to those with whom they work and in relation to their own learning and development, their values and behaviours. It will promote a hunger for continual personal development.

2, Research will support the 'How'; the curiosity to identify what new knowledge the masters student needs in order to complete the task at hand; the knowledge to create and execute a research plan that enables them to access the data that will provide that new knowledge; the capacity to synthesise that data into meaningful insights and the creativity to apply those insights to give meaning to them.

3, Innovation will deliver the 'What' in the context of application. It will deliver value-creation through the ability to make connections and collaborate, advanced creativity and strategic thinking and the leadership potential to turn ideas into realised solutions.

These core knowledge blocks are relevant to the designer anywhere along the spectrum, but they have little value unless they are exercised in context relevant to the individual. And none of this is worth a thing, unless they are tested in the 'dragon-pit' of real-world situations. For this reason, students pursuing new-mastery, at any point along the spectrum, will work collaboratively with each other and with commercial partners. Previous research with Design Innovation students [4] established the value of addressing business challenges rather than design briefs in pursuit of innovative solutions and this is very much the case here; anchoring the creative practice in a real-world context where its value can be measured.

4.2 Assessing New Mastery

The linear model presented above is, of course, far too simplistic. Contexts of application will span the doing-thinking spectrum and students' will develop their mastery in a 3-dimensional way dependent upon their own designerly purpose and an individual learning contract. Assessment has to reflect this and this is where a Portfolio of Practice [3] supported by a learning contract comes into play. Already in use at Northumbria University, the Portfolio of Practice provides students with the opportunity to provide a factual account of what has been done and to reflect upon what has been learned as a result. The learning contract, agreed with specialist academics with expertise in the discipline relevant to the student, is informed by the requirements of the context of application.

4.3 Impact

Understanding the impact and currency of our knowledge helps us assess the Mastery of students. The core of the knowledge required to support this assessment model is both robust, stable and industry relevant having been developed and refined through our existing programmes and research. It is continually refreshed and validated through the direct engagement that our students, academics and alumni have across the design disciplines and sectors.

The impact of the knowledge that we share can be seen in the changes that our alumni affect and the careers that they enjoy. It does not end at graduation; their knowledge is developed further through professional practice and comes back to us through collaborative projects, research activities and return to study at doctoral level for some of our graduates. These fundamental principles for New Mastery are as relevant to our programmes, where they are, in part, already being piloted, as they are for other institutions and practice-based subjects. Masters who know themselves, their discipline and how to create value through this knowledge by working with others hold the key to significant positive change.

REFERENCES:

[1] Adair, J. *Leadership and Motivation: The Fifty-Fifty Rule and the Eight Key Principles of Motivating others,* 1990 (London, Talbot Adair Press).

[2] Aftab, M. *Design as a functional leader: a case study to investigate the role of design as a potential leading discipline in multinational organisations,* 2013 (PhD, Northumbria University).

[3] Bailey, M. Working at the edges -liberating creative multidisciplinary participation by curriculum and assessment design. *ADM-HEA Networks Journal Feature Article*, 2010, 11(Sept).

[4] Bailey, M., Smith, N. & Aftab, M. Connecting for Impact - Multidisciplinary Approaches to Innovation in Small to Medium Sized Enterprises (SMEs). In.*DRS/Cumulus Conferenece 2013: The 2nd International Conference for Design Education Researchers.* Oslo, Norway, 14-17 May 2013.

[5] Berkun, S. The challenges of innovation. *The Myths of innovation.* 2010 (California, O'Reilly Media Inc.).

[6] Dye, P. Bright ideas for dark days. *Inspire and Innovate*, 2014, Retrieved on 27-1-2014, from http://www.theguardian.com/inspire-innovate/bright-ideas.

[7] English, Stuart G. Enhancing the Reflective Capabilities of Professional Design Practitioners. In: *Undisciplined! Design Research Society Conference 2008,* Sheffield Hallam University, Sheffield, UK, 16-19 July 2009.

[8] Gilsing, F. & Gardien, P. 'Walking the walk: Designing the Next Generation Design Organization', *The Design Thinking Conference.* Santa Monica, 2013 of Conference Design Management Institute.

[9] McCullagh, K. Riding the flux: Design is changing in myriad ways. Are you? *Core77,* 2007, Retrieved 24-2-2014, from http://www.core77.com/reactor/07.07_flux.asp.

[10] McCullagh, K. Is it time to rethink the T-shaped designer? *Core77,* 2010. Retrieved 17-1-2014, from http://www.core77.com/blog/columns/is_it_time_to_rethink_the_t-shaped_designer_17426.asp.

[11] Neumeier, M. Why T-shaped people are valuable but insufficient in an age of nonstop innovation. *Innovation Culture,* 2013. Retrieved on 3-1-2014 from http://lockwoodresource.com/finding-x-why-t-shaped-people-are-valuable-but-insufficient-in-an-age-of-nonstop-innovation-by-marty-neumeier/

[12] Press, M. & Cooper, R. *The Design Experience: The Role of Design and Designers in the Twenty-First Century,* 2003 (Hants, Ashgate Publishing Limited).

[13] Sinek, S. *The Golden Circles. 2013* (New York: Simon Sinek) Retrieved 12-1-2012 from http://www.startwithwhy.com/About.aspx?n=1.

[14] Overbeeke, et al. *Educational Model,* 2004. Eindhoven: Technische Universiteit Eindhoven. Retrieved 2-01-2013 from http://www.tue.nl/en/university/departments/industrial-design/education/exchange-program/educational-model/

[15] Vanderbilt, R. Skills first, or purpose first? A call for Y shaped individuals. *Plus Projects,* 2013. Retrieved, 12-1-2014, from http://plusprojects.tumblr.com/post/55705512353/skills-first-or-purpose-first-a-call-for-y-shaped

[16] Verganti, R. Radical Design and Technology Epiphanies: A New Focus for Research on Design Management. *Journal of Product Innovation Management*, 2011, *28*(3), 384-388. Retrieved 2-1-2014 from http://dx.doi.org/10.1111/j.1540-5885.2011.00807.x

[17] Yee. J., Jefferies, E. & Tan, L. *Design Transitions*. 2013. (Amsterdam: BIS).

Publication 3

Making it Work; Integrated Academic Practice

This double-blind, peer reviewed conference paper, published as a chapter in the proceedings of the 20th DMI Academic Design Management Conference; Inflection Point: Design Research Meets Design Practice (2016) situates the pedagogic principles developed in the preceding publications within the context of the three portfolios of contemporary academic practice; research, education and knowledge exchange (REF, TEF and KEF). It suggests that project-based activity with external partners can offer a situation that promotes high-quality, pedagogically sound, '**authentic', relevant, learning** whilst offering a research site from which to gather data and in which to validate new knowledge.

This publication presents a model of Integrated Academic Practice, IAP, located within the supporting structure and environment of a community of practice, which hosts this activity.

Within the context of this PhD submission, this publication is important because it identifies the modus operandum that underpins the action research and educational practices fundamental to the pedagogic orientation of the author and the research site: MDI.

Academic Design Management Conference

20th DMI: Academic Design Management Conference Inflection Point: Design Research Meets Design Practice Boston, USA, 22-29 July 2016

Making it work; integrated academic practice

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This research presents a model of Integrated Academic Practice that allows the three aspects of the academic portfolio; Research, Education and External Engagement to work in harmony in Design education. It highlights the reciprocal values that benefit Academia, Students and Partners in project- based knowledge co-creation and sharing.

The research has been conducted through case-study review of a decade of activity conducted in undergraduate and postgraduate Design and Multidisciplinary Innovation programmes at one design-renowned UK University where up to 80% of the curriculum is delivered through collaborative projects with external partners.

It suggests that project-based activity with external partners can offer a situation that promotes high-quality, pedagogically sound, 'authentic' learning whilst offering a research site from which to gather data and in which to validate new knowledge. In order to achieve this, the author's recommend that projects are established with clear purpose in mind. The research demonstrates how each of the stakeholders (students, academia and external partners) can benefit from this integrated way of working.

The paper concludes by proposing the conditions necessary to make Integrated Academic Practice work in Design Higher Education.

Keywords*: Integrated Academic Practice; Partnership Projects*

Introduction

Design educators have long celebrated the value of the 'live' project with a 'real-world' client as a high point in their programmes. Indeed, the existence of such projects is often cited as the reason why students choose

to study at one institution over another. The same educators also acknowledge that such projects place an additional burden on them when compared with running 'in-house' projects. With ever-increasing pressures on academics to respond to sector metrics associated with undertaking research, delivering impact and providing measurably high quality teaching, the barriers to working with external businesses are harder to ignore. Some academics are questioning whether these 'live' projects are a luxury that can no longer be afforded?

Many universities organise their activities through three distinct portfolios that, whilst given different names in different institutions, serve the same three functions; Education, Research and Engagement. Arguably, each is about delivering impact to society but through different channels;

- Education: equipping graduates with the knowledge, skills and creative confidence to bring about positive change
- Research: creating new knowledge with which to inform change through publication and application
- Engagement; working with external commercial, social and governmental organisations in order to develop the practice of the disciplines

In some disciplines these three portfolios of activity have evolved in a complementary fashion, the teaching hospital in which medical practitioners are educated whilst contributing to clinical research and simultaneously treating patients is the perfect example. Whilst creating organisational distinctions between portfolios of activity can still cause a certain silo mentality, in these more mature fields there is an irrefutable axiomatic complementarity.

Design academe is somewhat different. Since Frayling (1993) proposed his research 'into', 'by' and 'for' categorisation of design research, the discipline has struggled to disassociate the practice of design from 'research by design'. Friedman (2008) points out

> *In many situations, education and learning proceed by practising an art or craft. While we learn the art and craft of research by practising research, we do not undertake research simply by practising the art or craft to which the research field is linked.*

This is important because, increasingly, academics need to be able to express the research value of their work simply to satisfy institutional (and in some instances contractual) requirements, let alone advance knowledge within their discipline. Having a clear model that allows them to understand

and articulate the interconnectedness of their tripartite academic role will, therefore, be advantageous.

The purpose of this research is to identify the conditions that support an Integrated Academic Practice (IAP) model that will allow academics to capitalise on their research interests for the benefit of their students (as co- researchers), and society beyond, in a way that is complimentary rather than burdensome.

Scope

This paper focuses on one design school and the knowledge and experience gained from reviewing over a decade of undergraduate and postgraduate industrial and innovation design studies. The context of the paper is bounded by the single geopolitical HE policies directing the individual University strategy within which the study was conducted. Nonetheless, the paper draws conclusions that are intended to provide design academics working within any context a set of enabling conditions intended to help them achieve individual and team-based Integrated Academic Practice.

Methodology

This study builds upon research previously conducted through post- rationalisation of a decade of university/business collaboration between Northumbria University and Unilever as described by Bailey et al(2015). Over 20 projects were analysed against a set of criteria designed to reveal chosen attributes of each project. In that study, autoethnographic enquiry was supported by semi-structured interview and reflective workshops.

Knowledge gained from that study, along with subsequent in-studio student surveys, has been employed to help inform the creation of the IAP model proposed in this study.

Background

The site of this research, Northumbria University School of Design (hereafter NUSD), has an international reputation for the excellence of its teaching of design practice at undergraduate and postgraduate levels. It is also an acknowledged pioneer of multidisciplinary practice learning within design, and, between design, business, technology, and social science subjects. A characteristic of NUSD is the essential role that projects

(conducted between external partners, academics, and students) play in the curriculum.

NUSD plays host to the students with the highest academic points-score in their University and the brightest design students in their country. The academic team comes from different facets of design dealing with both theory and practice-based design research. In addition to the academic team, NUSD involves 'Innovators in Residence' (recent Masters Graduates who support the projects whilst being mentored by the University as they launch their own businesses) in their research and enterprise activities.

Pedagogy

The starting point of this work is education; delivering the highest quality design education through practice has been the 'core-business' of the NUSD since its foundations as one of the first UK Government Schools of Design in 1844 where

> *not theoretical instruction only, but the direct practical application of the Arts to Manufactures ought to be deemed an essential element. (Yarrington et al, 2005)*

Underpinning the School's approach is a pedagogy built on four elements that are all drawn together in the curriculum through design projects:

- Authentic practice

Establishing real-world authenticity is key to deep learning. Preparing students for the world of work, by exposing them to the complexities of professional situations is essential, but needs to happen within, what Bruner et al (1978), refer to as a 'scaffolded' environment. The foundation of the School's approach is project-based learning and teaching through design practice; directing undergraduates in the early years of their studies and progressively facilitating self-directed learning, through constructivist, experiential approaches as they develop and 'create their own knowledge' (Kolb 1984). This lays the foundations for their individual professional development. Setting projects as the central vehicle for learning and ensuring that they are conducted in a real-world context establishes the relevance of the learning to their future career aspirations thereby promoting amongst the students a desire to learn and understand.

- Cooperation

Design, in professional practice, is rarely a solo act and yet much traditional design education focuses on the individual. A more authentic approach, which is employed at NUSD, is based on students learning together in mixed-discipline project-based teams. Johnson & Johnson (1994) established five elements of cooperative learning. These are positive interdependence; individual accountability; face-to-face interaction; social skills; and processing. NUSD acknowledges this model through both the design of physical learning environments, programme structures, module structures, assessment design and project briefs that promote the development of these attributes. The result is that students establish trust between each other and, in the main, with their tutors and other support staff. This enables them to take creative risks knowing that those around them will be supportive.

Cooperative learning in design academe goes beyond the student-student interaction. We shall see later in this study that cooperative learning between academic, student and partner takes place when students are involved as co-creative researchers.

- Risk taking

Taking students out of their 'comfort zone' in a supported way, allows for deeper learning to be achieved. Traditional outcome-focused design education doesn't always promote this. Through a HEFCE funded pilot study (Bailey et al, 2010), it was established that students were more likely to 'play it safe' if the outcome of their design project was to be graded, whereas they were more experimental and took greater risks when the work was simply pass/fail. The higher education environment deters risk taking due to the high-stakes nature of summative assessment.

Based on the results of this pilot study, a 'safe' assessment-for-learning strategy intended to encourage creative risk-taking was developed and this is widely applied in NUSD, and in particular within the programmes where this study was situated. Using non-graded modules, at postgraduate level, each student presents a 'Portfolio of Practice' as an account of practice and a personal reflection of the learning derived from 'failure' and 'success' in that practice.

- Reflection

Design requires individuals who know their capabilities and have the capacity to nurture and access the different capabilities of others. Reflective Practice (Schönn, 1987) plays an important role in the development of self- awareness amongst design students, both in terms of their individual knowledge and capabilities but also in relation to how they work within teams.

The School's students develop as reflective practitioners who are involved as co-creators and active researchers in reflecting upon, evaluating and evolving new design and innovation methods employed in their programmes. Engaging students thus further develops their understanding and ownership (or construction) of their learning and their discipline (Bailey et al 2013).

Employing this pedagogy

These four pedagogic principles are the foundations upon which design learning at NUSD is built; learning from integrating theory and practice through projects in real-world situations, supported by reflection and an assessment strategy designed to promote learning, not simply grade performance.

For the vast majority of design students, we have found that the design project is the most effective vehicle for delivering this kind of integrated learning and the design brief is critical to this. Of around 300 final year undergraduate designers polled, only 4% reported looking beyond the project brief to other programme documentation. (Of that 4%, the majority had only consulted Module Descriptors or Guides when they had encountered a problem and wanted to challenge their grade! Only a tiny minority had done so to augment their learning). Organising the curriculum in such a way as to ensure that the theoretical as well as practical syllabus is addressed through a series of projects that borrow from 'scaffolding' theories and build knowledge suitably sequentially is a significant challenge in itself.

‘Live’ projects

Projects undertaken between student groups and external organisations are often referred to as ‘live’ projects. A ‘live’ project as defined by the LiveProjectsNetwork;

> *comprises the negotiation of a brief, timescale, budget, and product between an educational organisation, and an external collaborator for their mutual benefit. The project must be structured to ensure that students gain learning that is relevant to their educational development (Anderson & Priest,2015).*

Bailey et al (2015) conclude that “The live project is, in effect, an outcome-focused transactional project” and propose that projects undertaken through a partnership model working *with* collaborators offer greater potential to deliver true value to all stakeholders. Nonetheless, integrating the simple ‘live’ project into the curriculum with increasing pressures to deliver ‘high quality’ teaching and ‘high quality’ research (as measured through institutional and national surveys), is becoming too taxing for some academics; ‘we just don’t have the time anymore to deal with a contract, manage external expectations; we’ve got research and bureaucracy to deliver!’

But, we know that deep learning is achieved when what is being learned is authentic and relevant to the learners’ future aspirations: of projects undertaken with external partners, students have said;

> *An invaluable learning experience that provided instant insight into industry expectations which raised my professional approach and business acumen. (Multidisciplinary Innovation graduate)*

and

> *[it] stimulated me in the sense of having a good opportunity to practice for my future employment. (Industrial Design undergraduate)*

Basics of DesignResearch

This paper is not about design research per se but it is important in the context of considering the role of the contemporary design academic to think about what may be achieved within a new model of practice.

Friedman (2008) points out that Frayling (1993) didn't really define what he meant by 'research by design' and that this has left the way open for a misinterpretation, by some, (as he sees it) of practice as research.

Within this context, practice-based design research (through project working) offers academics the opportunity to deliver real impact beyond theoretical knowledge-creation (and the associated academic kudos achieved through publication). The application of emerging theory in practical situations working with external partners offers the opportunity to influence change, at scale, beyond academe.

Friedman draws attention to Nigel Cross's (1995) assertion that 'the best examples of design research are purposive, inquisitive, informed, methodical and communicable' and require 'articulate communication of explicit knowledge'. Irrespective of whether research is conducted into, by or for design, the purposeful pursuit of explicit, communicable new knowledge as the ultimate aim seems as relevant now as it was in 1995.
When we consider an Integrated Academic Practice model then, this should be the priority for the Research dimension.

Partners on projects

We have shown that external engagement with relevant partners benefits student learning through providing an authentic, real-world situation and that it enhances their employability. Similarly, we recognise that applying new and emerging knowledge in real-world situations offers opportunities to gather data, validate findings and has the potential to deliver impact through adoption of new knowledge and practices. What of the third stakeholder, the partner organisation?

In previous research (Bailey et al 2015) we have revealed that the value of engagement for the client company increases as the relationship progresses from the transactional live project to that of a partnership relationship. At best, the live project delivers a high volume of 'fragile ideas' as stimuli for future exploration and access to potential new recruits; both valuable in their own way.

A partnership level project is more nuanced to support broader benefits to the company including developing new ways of working, and addressing more strategic and long-standing corporate questions as well as the topic of

the brief. Some consider that issues of corporate strategy and how internal functions operate are beyond undergraduate students and too important to entrust to them. Of course they are if undertaken in isolation and unsupported. However, when partnership projects are structured to ensure that company employees, students and academics work together as co- creators of generative research, the results for the company can be dramatic;

> *The value for BA is that with Northumbria we are engaged in the development of new innovation practices. (Peter Cooke, Head of Design, British Airways)*

> *The work that the team at Northumbria are doing to foster the multidisciplinary approach has delivered multiple benefits to the Mars team; we see this approach as being of high value to industry as it represents best practice in innovation. (Sue Wilson, former Global Head of Design, Mars Inc.)*

> *This [Northumbria design-led approach] could be a new way of doing your business; it's creativity at it's core, and yes, once you have that you can innovate more scientifically (Pierre Starck, Unilever R&D - https://vimeo.com/128358762) (Bailey et al2015)*

In considering a model for Integrated Academic Practice, it seems wise to aim for the ultimate values that the partnership project has to offer the partner as identified in the aforementioned research (Bailey et al 2015), namely;

- Rapidity (generating data (ideas) very quickly);
- High Volume/High Quality (generating a large number of varied, high quality ideas)
- Compelling Communications (translating favourable ideas into compelling narratives for internal communication, discussion, development)
- Co-creation (transforming ways of working and employee mind-set through direct engagement)
- 'Beyond students' (establishing mechanisms for moving ideas beyond what students can achieve thereby extending the scope of research and potential impact of project)

Integrated Academic Practice model

How can we capitalise on this knowledge in order to establish a working model that allows us to deliver value to each stakeholder in equal measure and to balance the demands of the three academic portfolios? The key lies in making the project central to delivering the model, but understanding that it is simply a wrapper for pursuits within a bigger ecosystem of activity, and the wrapper may be perceived differently depending upon the focus of the viewer. Similarly, each sphere of activity requires different resources (human and physical) to ensure its success. (Fig.1)

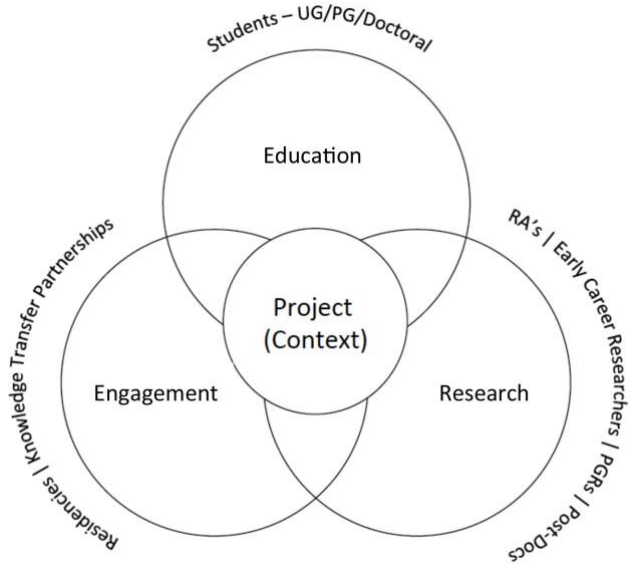

Fig. 1 – IAP model showing surrounding support resources

Education

From the design students' perspective we have seen that, underpinned by well considered pedagogy and a curriculum designed to facilitate project- based learning, projects are key. They package practice based application of theory into manageable chunks and, when undertaken with external

partners, reinforce the relevance of a design education in a professional, real-world situation. In order to maximise the potential for learning and the opportunity to achieve meaningful research through such projects, lead tutors need to be able to present the macro-view of the project; it's broader research aim and its true value to the partner organisation as well as ensuring that it delivers the critical curricular content that will enable students to achieve the prescribed learning outcomes. The rhythm of the project, as a design practice exercise, needs to be uninterrupted by the research and suitably supported to achieve this.

Research

Projects undertaken with collaborating partners and involving students as participant co-creators of generative research data offer academics a powerful resource. They facilitate a particular learning experience for students and partner organisations. However, in order to achieve meaningful research outcomes they need to be structured in a way that enables the lead researcher (who may also be the lead tutor) to answer the sort of specific, purposeful questions that Cross (1995) called for. And this purposeful research aim needs to be clearly articulated as part of the project discussion and contract negotiation in order that it can be appropriately resourced and valued.

Viewed from the research perspective, projects are often part of an on- going programme of research, rather than serving a single research purpose in their own right.

Engagement

It stands to reason that the project needs to be relevant to the business and of specific interest to the key personnel charged with overseeing its execution. However, there are numerous examples of disgruntled academics failing to understand why they haven't managed to impose their research upon businesses.

Historically, within the 'live project' approach, low-risk, 'back-burner' project topics are often selected for 'the student project'. This is entirely acceptable as far as it goes, but our research (Bailey et al 2013, 2015) shows that greater value, beyond the topic of the project, is achieved where the company stakeholders are more directly invested in the outcomes of the

project. A project of core strategic importance to a company will attract greater commitment and support from the partner. By this closer engagement (and co-creative involvement) partner employees will learn new ways of working and new ways of thinking about their situation. By positioning the project as an engagement with an academic community rather than as a 'student project' this can be reinforced.

Beyond the topic of the project, if the model is to work to its full potential, the partner needs to be fully invested in the value of the research enquiry. Indeed, their purpose in engaging with the institution in the first place may be to access research and new knowledge-creation in order to help them answer key corporate questions, and projects offering students the opportunity to be part of that research may be of secondary concern. If the academics work with the business to understand their needs and co- create the research questions, they are almost guaranteed support.

At Northumbria, partners invariably find that the design outputs from students' projects far exceed their expectations. They also pose as many new questions as they answer and very rarely provide immediately implementable solutions. This can lead to a sense of dissatisfaction 'that was great, but what happens next?' As a university, Northumbria's purpose is not to translate students' ideas into commercial value for external partners through consultancy activity. However, establishing a mechanism that allows students and recent graduates to contribute to knowledge exchange and generative research in order to create actionable R&D strategy with partners is. To this end, Northumbria have established an Innovator in Residence (IiR) scheme that supports recent graduates to establish their own start-up businesses and work with academics and student groups to develop projects beyond their typical curricular conclusion. This IiR scheme becomes an important dimension in supporting the Engagement aspect of the IAP model.

Case Study

The following case study presents an anonymised example of how this model was employed in 2015/16 with one multinational corporation. It has been replicated with a number of different organisations of different scales and the conclusions drawn at the end of this paper are a synthesis taken from these multiple instances.

This example started with a meeting between two senior company representatives (a Vice President and a Director of one of the world's largest companies) and two senior academics. The topic under discussion was the disruption of a stagnant market for a particular brand of product that is sold worldwide. The company in question has sophisticated, long-established and global R+D functions and a roster of the worlds finest design agencies working for them, any of whom could have been approached. Whilst the topic of discussion was about one particular brand and the product that it offers, the underlying question was a bigger one, discussed previously with the VP, and the reason why design academics and their students were being consulted; 'How can Design (as a function) help us to disrupt established brands/product archetypes in our business?' A previous project with a different part of the business had revealed the potential value of three particular aspects of Northumbria research that might help address this question; design-led multidisciplinary working, early co-creation with cross- functional stakeholders and a form of dynamic-mapping that one of the senior academics had been researching and developing. The new project was structured in order to employ all three of these aspects and to observe their effectiveness.

The response was constructed as a series of connected projects involving teams of undergraduate and postgraduate students together with the academics, Innovators in Residence (IiR) and key partner employees; collectively known as 'the team'. The project stages were constructed in order to take account of the levels and desired learning outcomes of the students involved, whilst enabling new knowledge about the topic and the bigger research questions to be developed.

In the first instance, the academics and IiR undertook an exercise to gather data about the market and product and to present this back to the partner as a visual taxonomy designed to sense-check their understanding and to act as the first stage in dynamic mapping. Based upon this taxonomy and the specific topic of the brief, 30 undergraduate industrial design students were introduced to the brief by the Director of the business together with the academics and the IiR. As part of the briefing, the students were engaged in an intensive workshop in order to elicit from them all of their collective tacit knowledge of the brand, market and product by means of problem-space tapestries (Bailey et al, 2013) – this

then fed into their establishing themes to address and teams in which to work.

The undergraduates worked through a series of staged activities supported by the team. They were able to present their emerging ideas regularly to the partner and work closely with the IiR to incorporate feedback in order to refine proposals that fitted closely with the specific consumer and partner requirements. At the end of this project, and following an intensive review with the Director, the team translated all of the students' proposals onto a dynamic mapping tool. The tool was tailored specifically in order to evaluate the ideas against a series of criteria derived from the initial taxonomy and emerging issues drawn from the project as it progressed.

The dynamic mapping tool, itself the subject of one on-going research enquiry, acted as a facilitating tool for the others; multidisciplinary working and cross-functional co-creation. The team used it to engage partner employees from different business functions (R+D, business strategy, fundamental research, technology etc.) in a far-reaching, 2-day workshop that enabled different disciplines to work together to imagine new futures for the markets, brand and products. As well as achieving cross-functional buy-in to the project aims, this was a first stage in revealing different ways of working for some employees.

Building upon the co-created data generated from this mapping and sharing exercise, the subsequent project enabled the team to focus on more specific proposals and to work at greater depth. It was designed to engage both multidisciplinary postgraduate student groups as well as a small cohort of undergraduate interns working with the IiR. This project looked much more strategically at the situation and enabled the team to engage with a broader commercial community within the business through presentations and further workshops.

These projects delivered far more than the original intention which was a product roadmap proposing a strategy for implementing disruption in the market (the answer to the question of the brief). The projects were used by the team to facilitate dialogue through workshops with other business functions whose roles would be directly impacted by the disruption of the market. Again, the purpose of these workshops was to drive new ways of

thinking and working in the business. In fact what they revealed was a need to work with these teams much earlier in projects in order to achieve their buy-in and understanding and benefit from their knowledge. Whilst this may seem obvious from the outside looking in, the core partner employees involved in the projects needed to experience this before this new way of working could be fully understood. Northumbria is now working with them to find ways to implement this knowledge in practice.

This suite of linked projects was particularly successful in delivering rich learning experiences for students and direct, topic-specific knowledge to the partner. In particular, the role of the IiR in facilitating a professional and on- going engagement was especially valuable to both the partner and the academics in maintaining the aforementioned project rhythm.

But what did we learn that could have been better and can inform our IAP model? This case study reinforced the position that equality of commitment to the project, as indicated in previous research regarding the value of 'partnership projects' (Bailey et al 2015) is key to delivering sustained value. With hindsight, and the benefit of conducting the research that is presented in this paper, it is clear that more specifically articulated research questions at the outset would have enabled a more systematic approach that allowed the projects to progress unhindered, but facilitated the collection of more empirical data along the way. This in turn would have allowed the findings to be more clearly articulated to the partner and helped us advance knowledge more quickly within the organisation.

This reflection in no way undermines the value of the work undertaken which has been lauded within the company as being of the highest standard and of immense direct value. What it does do is lay the foundations for a more refined and integrated way of working next time around.

Conclusions

This research, conducted as it has been within one institution, cannot present definitive conclusions to be immediately transplanted into another institutional setting. It can, however present the enabling conditions that might promote opportunities for both individuals (at a project level) and teams of academics (at a departmental or institutional level) to adopt this sort of integrated practice in order to simultaneously develop knowledge for

their discipline, learning for their students and benefit to their partners whilst maintaining a manageable workload.

It is clear, and entirely appropriate, that individual academics within design, position themselves differently with regard to their bias between teaching, research and engagement. Similarly different projects will not always sit centrally between the three folios due to the bias of the academics involved and the topic being explored. (Fig. 2)

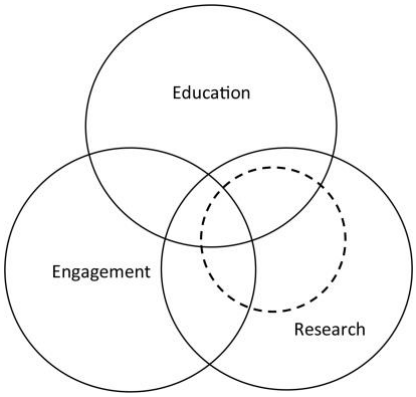

Fig. 2 IAP model illustrating a research-biased project in relation to other portfolios

What is important is that actors within a project are clear about where it sits and can adopt the relevant support and resources to secure success.

Enabling Conditions

From this research, we believe that the enabling conditions required to support an integrated approach to delivering success within each of the three portfolios thus:

- Sound Pedagogic underpinnings - a clear understanding of why, how and what students will learn through engaging with a project should be prioritised

- Clarity;

  - of purpose; being explicit about the aims and objectives of the project from the outset and recognising its position relative to the three portfolios in order that all those involved are aligned with these
  - of communication; being explicit about the purposes of the project with each stakeholder group at the outset
  - of support; matching resource requirements (both internal & within the partner organisation and human & physical) to the declared purposes of the project

- Relevance;

  - of educational value within the curriculum and relative to the syllabus
  - of research programme to the partner organisation; ensuring that the partner stands to gain from the new knowledge created as well as the topic explored
  - of context of the partnership; being sure that the partner shares the same perspective and values and represents a suitable learning and research site that will benefit students and society

Fundamental to ensuring that all of these conditions are recognised is the way in which the macro question to be addressed is expressed in the brief. For example, the following two questions can both result in a wide range of designs for new cups for the x-brand cup company:

- "What should the 2020 x-brand cup range look like?"
- "How can the function of Design change the way x-brand cups are designed for 2020?"

Both offer opportunities to research for and by design. The second question, however, also presents the opportunity to research into design as well. We have seen that involving students, in such enquiries into the role of their future profession is both motivating and empowering even at undergraduate level.

Perhaps, after all, it is not the classification of new knowledge in Design Research that is as important as the integrated nature of the knowledge in these projects that matters the most.

This research does not offer a silver bullet for design academics struggling with spiralling workloads and ambitions to serve three masters (or mistresses) at once. What it does do is present a means of visualising how, when considered as longer-term relationships rather than one-night- stands, apparently disparate activities might be aligned, married together, supported and, therefore, deliver results that are collectively more impactful than the sum of their parts.

References

Anderson, J., & Priest, C. (2015) *Live Projects Network*. Retrieved 24 Jan 2015, from http://liveprojectsnetwork.org/about/

Bailey, M. (2010) *Working at the Edges – liberating creative multidisciplinary participation by curriculum and assessment design.* Arts Design and Media, HEA Networks journal article

Bailey, M., Aftab, M. & Smith, N. (2015). *Hidden Value - Towards an Understanding of the Full Value and Impact of Engaging Students in User-Led Research and Innovation Projects Between Universities and Companies.* In Proceedings of the 3rd International Conference for Design Education Researchers (p. 290).)

Bailey, M., Smith, N., & Aftab, M. (2013). *Connecting for Impact- Multidisciplinary Approaches to Innovation in Small to Medium Sized enterprises (SMEs).* Design Research Society/Cumulus 2nd International Conference for Design Education Researchers, Oslo, Norway.

Bailey, M. (2015) *Northumbria University & Unilever | A Decade of Partnership* video retrieved 14 April 2016 from https://vimeo.com/128358762

Publication 4

Framing Strategic Value through Design-led Innovation Practice

This double-blind, peer reviewed conference paper, published as a chapter in the proceedings of the Design Society's DESIGN 2018, 15th International Design Conference (2018), and subsequently in translation in the Journal of Project Design Management (2018) identifies three separate 'value-frames' through which multidisciplinary design-led innovation projects, conducted using the IAP approach, deliver benefit to partnering organisations.

The research for this publication was conducted using a case-study methodology which identifies two particular aspects of the practice of the projects as particularly significant to the value achieved. These are 'Form Position': essentially setting the creative brief for the project following initial research and 'Communicate Narratives': identifying and deploying the most effective and appropriate forms of communication to reach intended audiences of the work.

The importance of this publication in relation to this submission is twofold: it highlights the importance of forming a position which the author has identified as the essential outcome of constructive, synthetic creative compromise and for students, the genuine value of their work to the organisations with whom they work as they study through IAP projects – it identifies them as co-researchers.

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FRAMING STRATEGIC VALUE THROUGH DESIGN-LED INNOVATION PRACTICE

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Abstract

In university/industry collaborative projects, full project value is often overlooked and such projects can be viewed simply as contributing to student employability agendas. Initially, collaborators tend to place value solely on the projects' created outputs. This paper reveals how strategic value evolves during such projects and identifies frame creation as a means of highlighting additional values in design-led innovation projects. Identifying 'value-frames' allows the academic team to be more purposeful in aligning project focus to partner objectives, thereby increasing impact potential.

Keywords: value driven design, design education, innovation

1. Introduction

This paper is concerned with design-led innovation projects conducted by multidisciplinary postgraduate students working with external partner organisations and academics; and the values that such projects can deliver to those partners.

Designers are familiar with the notion of problem framing. Cross (2015) describes problem framing as 'generating perspectives that engender new understanding of the problem and offer bridges to new solutions'. Dorst (2015) presents Frame Creation, a detailed approach to innovation practice through framing. Furthermore, Dorst and Cross (2001) explain how problem and solution spaces (or frames) co- evolve. They explain that the complex and networked nature of problems requires a bounded, or framed, exploration rather than solutionist approaches. Additionally, Mozota (2006) whilst highlighting the four powers of design i.e. design as a differentiator, design as an integrator, design as a transformer and design as good business concluded that each of these contribute towards creating substantial value for the organisation whilst framing problems and solutions.

This paper puts forward the case that the value(s) derived from such complex networked projects are framed and co-evolve as the project progresses. The research focuses on projects conducted as collaborations between academic staff specialising in design led innovation practices, Masters students from a Multidisciplinary Innovation programme, and middle and upper management employees from external partner organisations (hereafter referred to as the 'partner'). It puts forward the case for co- evolving strategic value and presents the concept of 'Value Frames' as a means to examine and understand how organisations are using the outputs, knowledge and insights produced by design-led University collaborations.

This research is concerned with the question: How does value evolve during design-led project collaborations and what forms of strategic value emerge? This study examines three project collaborations. The research does not attempt to compare the projects with one another. Each project is a separate case illustrative of three distinct strategic Value Frames. The research seeks to understand how

organisational value evolved during the collaborations, highlighting design-led practices that appear important in shaping and enabling that value. Each project, as a case study, demonstrates a shift in project targets and outputs. Each project was undertaken with the intent of delivering new product or service propositions, but in reality evolved, delivering different, additional forms of strategic value for the collaborating organisation.
In this study design-led innovation projects are run through a model of Integrated Academic Practice (IAP) (Bailey and Smith, 2016). IAP employs an enquiry-based pedagogy that involves students as co- researchers, engaged in research for, and with, the partner, working together with academics and professional practitioners. Using the project as the context for the enquiry, the process embeds both data-capture and testing to develop new knowledge about evolving approaches and practice(s). The IAP model works when stakeholders are embedded fully in the projects, working as co-creators within the team. Consequently opportunity exists for the individuals involved to learn through experience, allowing their ideas about the project to evolve as the project progresses.

2. Literature review

2.1. Design-led innovation

There is no conclusive agreement in literature regarding the precise role of design-led innovation nor its specific value (Design Council, 2016). However, there is concurrence regarding the importance of multi- stakeholder engagement. Bucolo and Matthews (2011) conclude that the main criteria for the success of their design-led innovation model is co-development, facilitated by design experts, with various stakeholders engaged throughout all stages of the design process. They suggest that the goal of design- led innovation is to ground stakeholder conversations around future propositions. They also stress the role of design methods that allow for vivid visualisations of proposed solutions as an important tool in a design-led innovation model.
Norman and Verganti (2014) promote the involvement of external stakeholders, referred to as interpreters, in order to fuel disruptive innovation. The involvement of multiple stakeholders requires methods that engage in a purposeful way. Kembaren et al. (2014) suggest three key stages that lie behind the success of multi-stakeholder, design-driven innovation in organisations: 1, Sensing; 2, Sense- making; 3, Specifying (setting up and storytelling as communication sub-stages). In the context of design-led social innovation, Manzini (2014) refers to a 'constellation of design initiatives' and multiple roles that designers can perform as both innovation triggers and facilitators of co-creative activity. He is consistent in reinforcing the importance of multi-stakeholder involvement and concludes that the designers' role is in 'making things happen' (*ibid*).
Whilst these authors consider approaches to achieving innovative output using a design-led approach, they do not stress the overall purpose of design, the value created by design or the values to each stakeholder of engaging in design-led innovation.

2.2. Design value

The value design has and how it can be applied within organisations has been explored within literature by numerous authors. Martin (2009) highlights how many organisations and leaders have turned to design methods to add value to their businesses, showing an openness to continuously redesign business practices. Yee et al. (2017) echo this through demonstrating seven roles of design that impact organisational transformation in order to achieve positive strategic change, citing the success of organisations including Deloitte, Spotify and Telstra. In addition, Cooper et al. (2016) found that organisations utilising design acquired benefits beyond styling, and describe how capabilities in design are

amongst the five most important sources of competitive advantage alongside: the quality of products, quality of services, and relationship with clients, but ahead of capabilities in manufacturing.

When embedded within an organisation's culture and processes, design can deliver strategic value through providing an environment where iterative experimentation is an essential part of the design process (Kolko, 2015). Brown (2009, p. 32) emphasises the need for a culture '[…] where people know they can experiment, take risks, and explore the full range of their faculties' in a safe environment where success is rewarded and failure is expected. In the case of the projects reviewed in this study, such an internal environment rarely exists for the partner employees involved. The university collaboration provides that safe environment for innovation (Bailey and Smith, 2010).

What is clear from the literature is that businesses in which design is applied, or granted permission to make decisions, do generate strategic value(s) by design. What the literature does not reveal is what strategic value(s) are derived from design-led multidisciplinary practices externally facilitated with enterprises where previously such designerly practices were absent, or of limited influence. The projects reviewed in this study are of this type.

3. Methodology

This study comprised three phases: The first phase reviewed 66 projects seeking to identify projects where the evolution of value was clear. This allowed the researchers to identify three projects where the evolution of value was clearly demonstrated and where the final organisational value was distinct and well articulated.

The second phase documented and interrogated the selected projects as case studies to describe the evolution of value and the final state of the value recognised by the partner.

The third phase sought to establish whether the types of value identified in the three case study projects were evident in the broader body of 66 projects reviewed. This final phase allowed the researchers to propose three distinct value frames.

3.1. Phase 1

All of the projects in the phase one review had, and delivered, a primary, intended, purpose - the development of a new product or service. Each project is documented with a:

- Project Brief, which contains the original project targets and expectations as well as a description of the project space;
- Project Materials produced during the project broadly catalogued under problem space, solution space, and strategic transition (understanding and plans to move the organisation to a position where it can deliver the solution propositions); and
- Project Value Interview (lead employees involved in the organisation are asked about the value they derive from the project and its potential impact on the organisation).

This review identified three areas where strategic value, beyond the brief, appeared to emerge:

1. development of new strategic direction,
2. changes in working practice or attitude and
3. designed assets used to leverage strategic investment.

3.2. Case study review

Phase two focused on three projects that delivered unexpected, additional value that was well documented and aligned with one of the three values identified in phase one. In each case it was clear that that the project had evolved to produce outputs and outcomes beyond new product and service propositions and that these were leveraged within the partner organisation to different strategic effect. Each of these projects was formed as a case study

and analysed in order to describe to determine and describe:

- Collaborator Context (to understand the problem setting);
- Original Project Challenge (to understand the questions, priorities and targets of the work)
- Key Activities (to describe the design-led approach influencing the evolution of value)
- Actions (a summary of key standpoints, insights and positions (frames))
- Key Finding
- Project Outputs
- Project Value

For each case study the researchers sought to understand how the project actions influenced the evolution of value. They also sought to understand: the organisational targets the work related to and if the work produced suggested new targets; if the work encouraged entrepreneurial practices and creative confidence within the organisation and; if the work had a direct impact on funding and resource allocation decisions. Semi-structured, independent project value interviews, conducted with key partner employees, informed this understanding.

3.3. Value mapping

Having, through phase two, understood more clearly, the nature of the three apparent types of value, the 66 projects were mapped against these three values in order to see whether there was any pattern and whether this would enable the researchers to frame the types of value. What emerged was a picture that illustrated that projects fell broadly into one of the three categories of value observed in Phase 1 and typified by the three case studies. Some projects sat very clearly in just one category whilst others straddled two or all three. The volume or intensity of value also varied. However, their general grouping did allow the researchers to draw some conclusions regarding the definition of the three emerging value frames delivered by this type of multidisciplinary design-led university/industry partnership project (Figure 1):

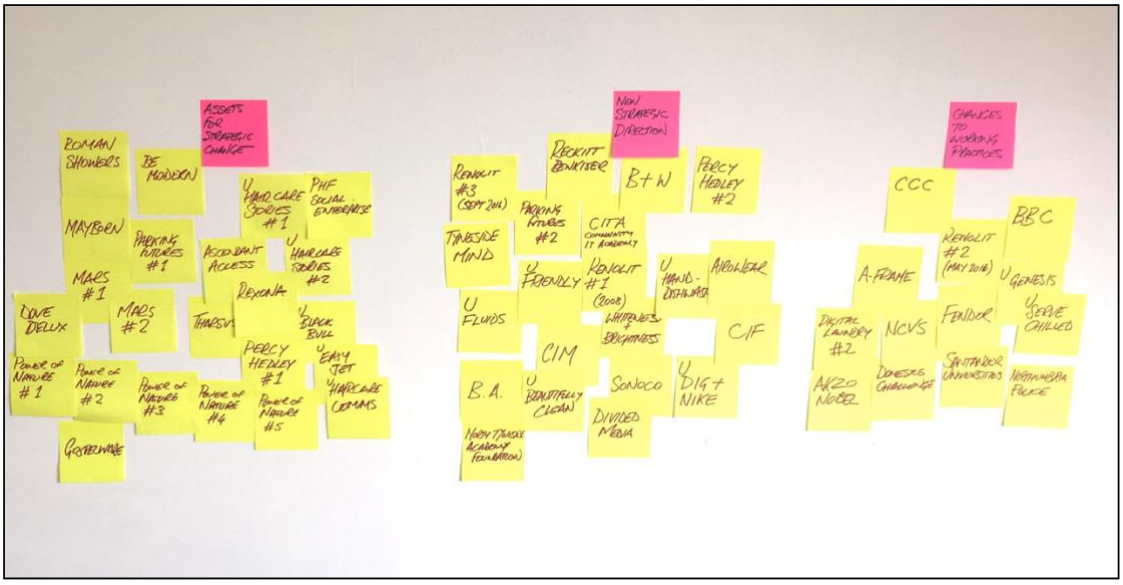

Figure 1. Projects clustered by strategic value

4. Case studies

Each project case study, presented in this section, involved the following common actors and roles:

- Senior academics (Design, Business & Technology) | project framing, direction setting, critical evaluation
- Multidisciplinary Innovation Master's students | mixed research methods, mixed design and business methods, co-creative practice
- Practice-based Researchers | literature and contextual practice review, solution development, communication & trialling
- Key partner stakeholders | Co-creators of understanding, framing, and solution trialling.

Dorst provides valuable guidance for frame creation. He defines 9 steps. In the projects reviewed in this research, there are 4 primary actions that map, broadly, onto the 9 steps: '*Find Out'* (understand and illustrate the complex challenge situation - what is it as a system, including processes, materiality and people; how different people view the situation and to what, within the system, their perspective relates); *'Form Positions'* (illustrate what the situation is and could be like); '*Explore Solutions'* (materialise through motion, shape and form); *'Communicate Narratives'* (create engagement materials) (Table 1).

Table 1. Frame Creation steps relative to Project Actions

Dorst's Frame Creation steps	Project Actions
Archaeology	Find Out
Paradox	
Context	
Field	
Themes	Form Position
Frames	
Futures	Explore Solutions
Transformation	
Integration	Communicate Narratives

3.1. Case study 1: Percy Hedley Foundation

Collaborator context: The Percy Hedley Foundation (PH) is a charity providing specialist, high quality, and innovative services for children, young people and adults with a range of physical and social needs. PH, within their Adult Services function, have developed a range of service-user enterprise ventures: Orion - professional print service, website development and music production; and Craftworks

- producing and selling a range of wooden, card, and horticulture craft products. These have emerged as a consequence of opportunity and staff interest. The organisation felt that now was an appropriate time to consider Social Enterprise as a potential revenue stream and to consider more broadly the appetite for developing the role of enterprise within the Foundation. The key stakeholders involved in this project were 50 members of PH (trustees, leadership team, management, care staff and service-users).

Original project challenge: The original project challenge set by the partner was to explore what new enterprises could be established within the context of the organisation and service user capabilities.

Key activities - Through site visits, semi-structured interviews with members of the leadership and governance team, and discussions with a range of staff and service users the team developed an understanding of what 'enterprise' means and could mean to PH. Literature and regional best practice case studies were used to situate understanding emerging from within PH about enterprise. These research activities took place concurrently with design-led innovation practice feeding and being informed by on-going discussions between the academic lead and the Foundation's Director of Adult Services. 16

Multidisciplinary Innovation masters students' design-led innovation practice explored how new or modified services could be materialised through a culture of enterprise and how they may be developed, run and evaluated. During this project the students designed, developed and ran two co-creative workshops with a cross-section of PH, including: trustees and members of the executive team; management and support staff from the school, adult services and residential care; and day- service users. Their practice drew together a network of stakeholders with different priorities and perspectives to:

- Collaboratively develop a common understanding of 'enterprise' and 'enterprising'
- Explore how this understanding might materialise within the organisation,
- Consider what consequences, rights and responsibilities, might result.

Understanding and thinking emerging from across this range of activity was integrated into a set of principles and practices which formed the recommended 'model of enterprise'.

Actions:

1. **Find Out** - What does enterprise mean within PH and why does it hold value?
2. **Form Position** - What would it look and feel like if PH had an enterprising culture and coordinated approach to enterprise?
3. **Explore Solutions:** Development of a program of project-focused enterprising endeavours, which united staff and service users to use new and existing day services to plan, promote, produce and disseminate (exhibit or trade).
4. **Communicate Narratives:** Creation of a number of narratives and materials illustrating this programme and the development the short, medium and long term needs of the organisation.

Key findings in the project - PH want to develop and show off the talents of their service users; they want to be known as a leading enterprising charity; they are worried about the impact that being business focused will have on care (or perceptions of care); PH are very enterprising but have yet to coordinate their approach, development and delivery.

Project output - A model of enterprise (purpose, roles, output and impact) for the whole organisation and support resources, locating a system of planning, delivery and evaluation against the organisation's strategic objectives.

3.2. Case study 2: Good Careers Guidance

Collaborator context - Churchill Community College (CCC) is one of 13 schools and 3 colleges participating in the Gatsby Good Careers Guidance pilot project (NELEP, 2015), which is managed by the North East Local Enterprise Partnership (NELEP). The pilot aims to test the eight benchmarks identified in the Good Careers Guidance report (Holman, 2014) and collect evidence on the impact of structuring career information, advice and education guidance in this way. In January 2016, as part of the pilot, CCC successfully secured funding allowing Northumbria University to undertake design- led research to produce understanding and solutions to help address the Gatsby Good Careers Guidance Benchmark 6: Experiences of the Workplace: 'Every student should have first-hand experiences of the workplace through work visits, work shadowing and/or work experience to help their exploration of career opportunities, and expand their networks' (Gatsby Good Careers Guidance Report).

Gatsby refers to 'Experiences of the Workplace' as opposed to work experience that has a tradition and history that can be limiting when thinking about how schools might respond to and address this benchmark. Experience of the workplace does not have to involve the traditional one or two-week placement; effective experience programmes can involve, but are not limited to: work shadowing, 'take your son or daughter to work' days, extended school visits to workplaces and episodic work experience over a longer time period, interspersed with periods in school. The key stakeholders involved comprised staff and pupils of CCC, staff from schools within the pilot scheme, careers guidance experts and members of the NELEP.

Original project challenge - Produce implementable solutions to help CCC address the Gatsby Good Careers Guidance Benchmark 6: 'Experiences of the Workplace'. Solutions must be sustainable beyond the Pilot Project funding and must be transferable to other schools to enable national scaling.

Key activities – Conducting desk research and interviews with key staff from the various institutions involved in the project, as well as running co-creative workshops with pupils and participants from across the organisation (Figure 2). Delivering key insights and clear positions to respond to Benchmark 6.

Actions:

1. **Find Out** - What is a 'meaningful' experience of the workplace and how can different schools within different contexts deliver this?
2. **Form Position** - Due to contextual differences, different schools deliver careers guidance in *very* different ways meaning that solutions would need to be flexible and adaptable.
3. **Explore Solutions** - Individual concepts were developed and trialled before a three-stage framework was designed. Designed templates and resources supported the framework.
4. **Communicate Narratives** - Deploying the resources in 6 pilot schools identified a need to redesign the resources to adopt schools' vernacular in order to be more readily accepted and used. This also generated 6 case studies of successful application of the framework

Figure 2. Students facilitating co-creative workshop with academics, researchers, pupils and staff of CCC

Key findings in the project - Pupils who did identify a chosen career or industry had limited knowledge of access pathways; pupils tended to have a singular focus rather than being open to flexibility and change in their future career.

Project output - A Careers Guidance Framework designed to ensure a holistic approach to careers guidance in schools. This framework empowers teachers to develop a programme of activities that is innovative and enterprising and delivers meaningful careers guidance as well as providing a structure for schools, businesses and 3rd party providers to use when

delivering careers guidance. Templates and guides have been provided alongside evidential case studies for reference.

3.3 Case study 3: Power of Nature

Collaborator context: The collaborating partner is a global Fast Moving Consumer Goods manufacturer exploring highly disruptive new science and technology innovation for a range of household applications. Adoption of the new technology has the potential to disrupt the business and sector. 18 Multidisciplinary Innovation students were involved. Key stakeholders were 2 research scientists (1 the partner's project lead, 1 a Visiting Professor 'science interpreter'), typical consumers. **Original project challenge:** The principal challenge was to translate complex, new and in some cases negatively perceived by the general public, scientific discoveries into meaningful and compelling product concepts and communication material in order to generate internal business support for continued research. **Key activities –** Detailed briefings with the partner's lead project scientist set the macro context (global mega-trends, policy context, business context) and the micro context (the science itself, how it works, what it could do and how this might relate to individual consumers in specific instances); extensive interpretation sessions with the Visiting Professor using analogies, metaphors and storytelling as an approach to: a, learn about the science in layman's terms and b, explore possible design-communication directions; desk-research; observational research of user behaviour in potential application scenarios; design conceptualisation; business-model conceptualisation; iterative development and refinement of communication strategies and associated collateral.

Actions:

1. **Find Out -** Understand the science, understand potential consumer benefit(s) and supporting business cases
2. **Form Position -** Based, in-part on the Macro-Micro toggling approach (Bailey et al. 2016), the team identified that in order to gain traction and therefore strategic buy-in, impactful communication would need to focus on end-user (micro) benefit (translating to new business opportunities) rather than corporate or environmental (macro) worth which is ultimately the desired and intended consequence of commercial success.
3. **Explore Solutions -** Through adopting speculative design approaches, multiple alternative communication concepts in early mock-up form (animations, faux-adverts (both film and poster), storyboards, product mock-ups and prototypes) were rapidly developed and shared with the partner and potential consumers. This was an iterative approach with multiple cycles leading to refined concepts.
4. **Communicate Narratives -** For internal (client organisation) communications a suite of macro (corporate, environmental) assets were envisioned, supported by micro (consumer benefit) material. In this way, the lead research scientist was able to reach beyond the scientific community in order to explain the full business potential, in consumer-facing terms that sales, marketing, commercial functions within the business would understand. The narrative was presented in 'their language' through highly professional, believable, finished materials.

Key findings in the project - The most complex (scientific) concepts can be broken down into simplistic explanations using metaphor and storytelling as part of a briefing process with a design-led multidisciplinary innovation team. This has a number of benefits: it reveals where misunderstanding amongst lay-people might lie; it necessitates the creation and adoption of new forms of description which may, in turn, lead to concepts for the final delivery material; it can identify new potential market opportunities as descriptions are explored and tested; identifying key audiences and adopting their language is a key aspect of position forming.

Project Output - A portfolio of communication pieces each of which presents specific complex science deployed to deliver end-user benefit in different use scenarios and global

markets. These have been created to suit both internal and external audiences in a way that brings the science to life through speculative design that recognises the multiple different perspectives from which different stakeholders would draw benefit and value.

4.0 Research findings: Three Value-Frames

Strategic Value, 'the degree to which a particular action or planned action is important or useful in relation to something that [the enterprise] wants to achieve' (Cambridge Dictionary, 2018), can evolve through university/industry collaborations as an added value beyond the new product or service that was the primary purpose of the collaboration. Furthermore, such values can be framed through the four actions: Find Out; Form Position; Explore Solution and Communicate Narratives. The three Value Frames identified in this study are:

4.1. Co-created strategy

Co-created strategy is the identification of a new business target and plan for achieving it. It takes advantage of designerly activities in order to support strategic organisational review and direction setting.

Designerly activities allow participants to 'see' future potential by adopting alternative frames through which to view their business activities. These may include the production of visions of new products or services or new enabling collateral. Such collateral delivers value by encouraging partners to shift their mind-set by taking the available data about a given situation and framing it in order to present alternative meanings derived from it. Whilst the tangible outputs of projects delivering value within the co-created strategy frame may be proposals, artefacts and plans, the true value is in the intellectual transformational mind-set of reframing.

For example, for Percy Hedley, the project value was a new way of understanding Enterprise and its potential value to the Foundation. The academics leading the work formed the position to support the partner's agenda by considering the question: how can the principles of enterprise be applied to generate greater self-development and social inclusion opportunities for those who currently utilise day-services and have a range of impairments, and what organisational adaptations would be required? PH now use enterprise as a mechanism. Through this mechanism people at Percy Hedley are engaged in a programme of project-focused endeavours, consisting of day-to-day activities that are purposeful for the endeavour and meaningful for the individual. This understanding is now written into their development strategy and represents a significant shift in organisational mind-set.

In this case we can see the key importance of co-creative activity with a wide range of stakeholders. This was key to changing the perception of care, which in turn, unlocked a new way of envisioning the enabling qualities of enterprise as a dimension of care-giving. The co-creative nature of the work that led to this realisation made it possible to shift organisation mind-set with regard to developing and introducing an enterprise strategy. By deploying designed collateral based on co-creative activity with the stakeholders the project established a collective sense of ownership in the future direction.

Engagement in, and outputs of, the project resulted in the partner understanding their challenge in a different way or from a different perspective. As a result of working co-creatively with the design-led team, enterprises are enabled to re-frame their proposition and envision alternative strategies.

4.2. Creative Functionality

Creative Functionality shifts the innovation mind-set of the organisation by helping enterprises to adopt a more entrepreneurial attitude to innovation through capitalising on latent internal capabilities and capacity.

It uses design-led approaches to develop or adapt organisational functionality (systems, processes, and behavioural practices). For those individuals involved it grants permission to adopt a more entrepreneurial attitude to innovation and experimentation. Through design-led, multidisciplinary co- creative activities, which take advantage of the context of the organisation, value can be delivered to the partner through frameworks, processes and organisation-specific tools. These promote bounded, or 'safe', creative risk-taking to be established within organisational culture.

For example, CCC and NELEP now have an evidence-based framework, co-developed with the university multidisciplinary team, with which to drive a 'safe' creative approach to developing context- relevant solutions and creative culture-change in schools. This is very different from the declared 'actionable solutions' required of the initial brief, but offers a sustainable means by which schools can create and deploy their own solutions.
This was a highly complex project with multiple stakeholders possessing conflicting objectives, but an overriding desire to receive implementable solutions. By recognising the wide variation in contexts within which the solutions were required, the academics were able to form the position that an alternative approach was required. This led to the team co-creating a framework that would enable stakeholders in each context to develop their own solutions. Acceptance of this approach was only truly achieved when its effectiveness was demonstrated, and repeated, in real-world settings. This suggests that emphasis should be placed on establishing means of early demonstration within Creative Functionality in the future in order to achieve earlier buy-in.

4.3. Leveraging Strategic Change

Leveraging Strategic Change uses design-led approaches to help the partner visualise the future impact of innovations and thereby drive organisational strategy, funding and resources. It is achieved through the development of critical insights and explorative ideas delivered through compelling narratives presented as a range of designed collateral (e.g. adcepts, posters, artefacts, videos, campaigns etc.). All of these have the purpose of bringing ideas to life in tangible ways that are presented in appropriate language for any given decision-making audience thereby allowing innovation opportunities to be evaluated from different disciplinary and functional perspectives.

For example, Power of Nature started as an experiment to see whether the design-led approach would produce outputs that could influence internal decision-makers. Key to the success of this work was the

position formed by the academics, and partner, that multiple audiences required multiple communication strategies capitalising on understanding of the language of each audience. An on-going developing portfolio of associated projects with the same partner is evidence that the design-led speculative outputs of these projects (user-focused design concepts employing the new science and delivered as highly professional marketing material simulations) are strong tools that assist the partner in leveraging strategic internal, external-collaborator, trade-body and research council backing to bring the technology to market.
Leveraging Strategic Change is about enablement. The case study research showed revealed a critical interpretive role required in order to ensure the materialised narratives are presented in the right language for the intended audience thereby delivering enablement. In this case, a highly design literate interpreter (the Visiting Professor), coupled with deep knowledge of the partner's various functional traits which the academic team had built up over years of collaboration, fulfilled this role. Recognising the fundamental importance of this in delivering outputs that leverage strategic change, in future IAP projects, emphasis can be

placed on its importance in the project setup and recruitment of actors.

5. Learnings and further research

It is evident that a single project may deliver value across all three value-frames and that there are multiple factors that will determine whether the potential value as identified at a project's conclusion can be realised in the longer-term. Understanding and being able to influence the factors involved in delivering strategic value over the long-term is an important next step in ensuring that these types of design-led interventions deliver the desired impact as well as value.

Through the use of design, it is well understood and accepted that problem and solution understanding co-evolve while solving complex, ill-structured, wicked problems (Dorst and Cross, 2001). Good Careers Guidance is a good example of this. Through design-led innovation practice, whilst attempting to develop solutions, the team also developed in-depth understanding of the problem. This evolved understanding did not necessarily lead to a refinement of the solutions being developed but led to a new way of seeing that, in turn, led to describing new ways of doing. It shifted the frame through which the challenges and constraints could best be resolved and from which solutions could be developed.

In reviewing the four actions across the three case studies, it is evident that value creation is most impacted by Form Position and Communicate Narratives. Find Out (research) and Explore Solutions (design and develop) are essentially 'standard R&D' practices.

Considering the 7 roles of design identified by Yee et al. (2017) in commercial design practice: Cultural Catalyst; Framework Maker; Humaniser; Power Broker; Friendly Challenger; Technology Enabler; Community Builder, in relation to these university/industry multidisciplinary design-led project value frames it is possible identify an 8th role: Expert Authority. This is the role performed, predominantly by the academics, but informed by the students, researchers, partner and stakeholders, when they Form Position.

This study has allowed a conceptual framework to be established that defines three distinct value-frames but it poses further questions:

- Is it possible to use this knowledge to be more purposeful in attempting to set-up projects to deliver specific strategic value?
- What is the long-term value: without further intervention, how sustained and prevalent will the value be within the partner organisations?

6. Conclusion

This review has shown that strategic value in design-led multidisciplinary university/industry projects co-evolves alongside problem understanding and solutions development. Understanding that this is most greatly influenced by position forming means that it should be possible to be more explicit about what value(s) a project is intended to deliver at its inception and focus on ensuring that these are delivered. This means that the academic team, in framing and establishing the project with a partner will be able to work with them to form a collaborative position for the project focussing on the desired strategic goal whilst being cognisant of other emerging strategic values may emerge as the project progresses.

Within an educational setting, having the ability to be explicit about these value-frames and the different perspectives that they offer, allows students understanding of the multiplicity, impact and value that design-led innovation offers organisations. Consequently this means that a balanced curriculum can be planned through which examples of each value-frame are experienced.

What this review has clearly shown is that, whilst the activities, resources and actions deployed in these projects are essentially the same, there are values created (beyond the student outputs) from which partners who are deeply engaged in the projects will benefit. Beyond the value delivered by responses to the original brief, these values offer the potential to deliver impact within both the organisational setting and academe.

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References

Bailey, M. and Smith, N. (2010), "Safe Environments for Innovation-Developing a New Multidisciplinary Masters Programme", *Proceedings of EPDE 2010 / the 12th International Conference on Engineering and Product Design Education - When Design Education and Design Research meet…, Trondheim, Norway, September 2-3, 2010,* The Design Society, Glasgow, pp. 60-65.

Bailey, M. and Smith, N. (2016), "Making it Work; Integrated Academic Practice", *Proceedings of the 20th DMI: Academic Design Management Conference Inflection Point: Design Research Meets Design Practice, Boston, USA, July 28-29, 2016,* DMI, Boston, pp. 2346-2363.

Bailey, M., Spencer, N. and Sams, P. (2016), "What on Earth is Responsible Innovation Anyway? – making it happen", *Proceedings of the EPDE 2016 / 18th International conference on Engineering and Product Design Education, Aalborg, Denmark, September 8-9, 2016,* The Design Society, Glasgow, pp. 234-239.

Brown, T. (2009), *Change by design: how design thinking transforms organizations and inspires innovation*, Harper Business, New York.

Bucolo, S. and Matthews, J.H. (2011), "Design led innovation: Exploring the synthesis of needs, technologies and business models", *Proceedings of Participatory Interaction Conference 2011 (PINC 2011), Sønderborg, Denmark, January 13-15, 2011,* University of Southern Denmark, pp. 354-357.

Cambridge Dictionary (2018), *Strategic value*. [online] Available at: https://dictionary.cambridge.org/dictionary/english/strategic-value (accessed 05.03.2018).

Cooper, R., Hernandez, R., Murphy, E. and Tether, B. (2016), Design value: The role of design in innovation, Lancaster University, Lancaster.

Cross, N. (2015), *Endorsement of "Frame innovation: Create new thinking by design" by Dorst, K.* [online] MIT Press. Available at: https://mitpress.mit.edu/books/frame-innovation

Design Council (2016), *Invitation to Tender*. [online] The Design Council. Available at: http://www.designcouncil.org.uk/sites/default/files/asset/document/Design-led%20innovation%20ITT%2004.11.16%20(2).pdf (accessed 01.03.2017).

Dorst, K. (2015), *Frame innovation: Create new thinking by design*, MIT Press, Massachusetts.

Dorst, K. and Cross, N. (2001), "Creativity in the design process: co-evolution of problem solution", *Design Studies*, Vol. 22 No. 5, pp. 425-437. https://doi.org/10.1016/S0142-694X(01)00009-6

Holman, J. (2014), *Good Careers Guidance.* [online] The Gatsby Foundation. Available at: http://www.gatsby.org.uk/uploads/education/reports/pdf/gatsby-sir-john-holman-good-career-guidance-2014.pdf (accessed 01.04.2016).

Kembaren, P., Simatupang, T.M., Larso, D. and Wiyancoko, D. (2014), "Design Driven Innovation Practices in Design-preneur led Creative Industry", *Journal of technology management & innovation*, Vol. 9 No. 3, pp. 91-105. https://doi.org/10.4067/S0718-27242014000300007

Kolko, J. (2015), "Design thinking comes of age", *Harvard Business Review*, Vol. 93 No. 9, pp. 66-71.

Manzini, E. (2014), "Making things happen: Social innovation and design", *Design Issues*, Vol. 30 No. 1, pp. 57-66. https://doi.org/10.1162/DESI_a_00248

Martin, R.L. (2009), *The design of business: why design thinking is the next competitive advantage*, Harvard Business Press, Boston.

NELEP (2015), *Good Careers Guidance Benchmarks Pilot*. [online] North East Local Enterprise artnership. Available at: https://www.nelep.co.uk/skills/north-east-ambition/ (accessed 01.12.2017).
Norman, D.A. and Verganti, R. (2014), "Incremental and radical innovation: Design research vs. technology and meaning change", *Design issues*, Vol. 30 No. 1, pp. 78-96. https://doi.org/10.1162/DESI_a_00250
Yee, J., Jefferies, E. and Michlewski, K. (2017), *Transformations: 7 Roles to Drive Change by Design*, BIS Publishers, Amsterdam.

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Publication 5

Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?

This double-blind, peer reviewed conference paper, published as a chapter in the proceedings of the 20th International Conference on Engineering and Product Design Education reports on a pilot study in which design thinking approaches employed within the MDI programme, were deployed to explore a complex challenge in an atypical field for design: designing future education. The pilot was conducted within the context of an EU-funded global research programme in which the author was a co-investigator.

The significance of this work to the submission is that it demonstrates the application of the author's C-SKV and creative compromise approaches in an expanded field, it positions participating students as co-researchers and it represents a more experimental, generative research project.

6 & 7 SEPTEMBER 2018, DYSON SCHOOL OF DESIGN ENGINEERING, IMPERIAL COLLEGE, LONDON, UNITED KINGDOM

BEYOND DISICPLINES: CAN DESIGN APPROACHES BE USED TO DEVELOP EDUCATION FOR JOBS THAT DON'T YET EXIST?

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ABSTRACT

http://epde.info/epde2018/about-epde/*Keywords: Design Education, Future Employment, Workshop Design, Post-disciplinary Education*

1 INTRODUCTION

At a time when the role and purpose of universities is increasingly being questioned; when modes of study are increasingly varied; when higher education has become increasingly marketised; when large employers are declaring that a degree will no longer be a pre-requisite for hiring and when the disciplines are changing rapidly, disappearing altogether, or new ones emerging, how can we determine what we should teach in the future and how it should be taught? In such a climate, can universities continue to conform to old constructs of discipline, or are we entering a new era where skill, competency and attitude play a more significant role when employability is the goal? If this is the case, what can we learn from the pedagogies of art and design education that might be of value more broadly?

In this paper the authors reveal the design, development and delivery of a pilot study exploring the potential of adopting a co- creative design-led approach to designing education beyond disciplines. The key protagonists were a cohort of post-graduate students from diverse disciplinary backgrounds studying innovation working with a number of multidiscipline academics and researchers. The paper describes how the academics and researchers drew together relevant literature and adopted a design- led approach to design the pilot project. It then goes on to detail how the pilot project ran and what the cohort created. Further it evaluates the effectiveness of the pilot in revealing useful knowledge for the development of new higher education programmes. Finally, it concludes by identifying how the pilot will inform a subsequent suite of follow-up projects to be repeated at a number of different universities in mainland Europe and South Korea.

The research has been conducted as part of an EU Horizon 2020 Framework, Marie-Sklodowska-Curie Actions, RISE grant project. The project is entitled Global Entrepreneurial Talent Management 3, GETM3. This international project, involving 8 partner universities and multiple employer partners in 5 countries 'in transition' in Western and Eastern Europe, and South Korea, is working with three stakeholder groups: Students and Graduates (future employees); Employers (future wealth creators) and Higher Education Institutions (educators of the future) to explore the role of higher education in narrowing the gap between the expectations of employers and those of entrepreneurial recent-graduate employees. In the case of the pilot study described in this paper, this question is being addressed through generative research around the question "how should universities prepare graduates for jobs that don't even exist yet?" The outcomes of this work and the subsequent follow-on projects will inform the overall findings of the GETM3 programme.

Table 1. Top 10 skills employers seek

	Parade	Climb Professional Development	National Association of Colleges & Employers	Live Career	Target Jobs	Skill by Rank Aggregation
1	Ability to Prioritize	Strong Communication Skills	Ability to work in a team	Communication	Commercial awareness	Communication
2	Works well in team	Analytical & Research Skills	Problem Solving	Organization	Communication	Teamwork
3	Organizational awareness	Computer Skills	Communication (written)	Teamwork skills	Teamwork	Organization
4	Effective problem- solving	Adaptability & Flexibility	Strong work ethic	Punctuality	Negotiation & Persuasion	Problem Solving/creativity
5	Self-aware	Problem Solving & Creativity	Communication Skills (verbal)	Critical Thinking	Problem Solving	Analytical
6	Proactivity	Teamwork	Leadership	Social Skills	Leadership	Flexibility
7	Ability to influence	Planning	Initiative	Creativity	Organisation	Negotiation
8	Effective Decision Making	Decision Making	Analytical/quantitative skills	Interpersonal Communication	Perseverance & Motivation	Leadership
9	Learning Agility	Organization	Flexibility/adaptability	Adaptability	Ability to work under pressure	Technical
10	Technical savvy	Leadership	Detail-oriented	Friendly Personality	Confidence	Proactive

Table 2. Top 10 skills delivered by art and design education

	Ball et al 2010	Bridgstock & Cunningham 2016	Skill by Rank Aggregation
1	Creativity & Innovation	Creative discipline specific skills	Communication
2	Visual Skills	Communication /Teamwork	Teamwork
3	Presenting ideas (communication)	Communication /Teamwork	Problem solving Creativity
4	Research Skills	Generic creativity	Organization
5	Collaborating with others	Critical thinking	Flexibility
6	Making/Technical/Design skills	Self, time & project management	
7	Flexibility/adaptability	Discipline specific knowledge (technical)	
8	Self Management (Organisation)	Digital skills	
9	Problem Solving	Problem Solving	
10	Self Confidence	Entrepreneurship, business management	

Shreeve et al in their 2010 article, ‘‘A kind of exchange’: learning from art and design teaching,’ [5] identified that education in this domain, which results in ‘independently creative’ graduates, is typified by student-centred, experiential, experimental, ontological and dialogic pedagogies supporting a ‘fluid curriculum’. Wastell, 2014, [6] highlights how adopting a ‘design attitude’ in business studies achieves ‘relevance’ and Glen et al, 2014, [7] highlight the value of design thinking pedagogies to promote adaptive reasoning, essential for addressing ill-structured situations. The implication for HE more broadly, in responding to the employability agenda, is that the approaches adopted in Art and Design education may have a more diverse role to play in delivering the key skills sought by employers, irrespective of disciplinary field.

In order to understand more about what graduates see as important in the workplace, the authors have used a Design Thinking [8] workshop to elicit from students their ideas about the role universities might play in narrowing the gap between employer and employee expectations of the workplace (i.e. psychological contracts). By comparing their work with the skills and educational approaches identified above, we may infer a future role for design education beyond the design disciplines.

2 METHODOLOGY

This research has been conducted through a multi-method approach involving reflection in, and on practice, observation, semi-structured interview and ‘dynamic prototyping’ to collect the perspectives of students as future employees. The paper is a reflection on the preparation, delivery and evaluation of a workshop pilot, in other words, a prototype. During delivery of the pilot, the authors facilitating the workshop, reflecting in action, found it necessary to modify their plans in real-time, hence the term ‘dynamic prototyping’. The cohort who participated comprised 17 students representing 8 different nationalities who between them have experience of studying in 6 different countries, 12 different subjects including mathematics, fine art, journalism, software engineering, sociology and design. They have between 0 and 10 years of professional employment experience.

3 WORKSHOP DESIGN

As its context, the workshop was designed to respond to Prof Martin Boehm's, 2017 question [9]:

"We see significant changes in labour markets of the future. […] Eighty percent of jobs that will exist in 2025 don't exist today; we have to prepare our students and graduates for a world that's essentially not possible to prepare them for. That's clearly going to be a challenge, and it has implications for the pedagogical approach: what are we actually going to teach in our programmes?"

Partners from across the GETM3 network contributed resources that captured stakeholder contexts. They also invited colleagues to participate in the planning, delivery, execution, evaluation and evolution of the initiative. The authors are experienced in running co-creative rapid design exercises using adaptations of the Google Ventures Design Sprint approach which follows five stages of activity over a five day period: Unpack; Sketch; Decide; Prototype; Test, all preceded by a 'Set the Stage' period of preparatory work. In this case, time was limited to two days for the workshop, and, therefore an accelerated approach was called for which was delivered over 4 sessions: Unpack (problem- framing); Sketch (ideation); Decision & Revision; Communication.

The design-led innovation academics at Northumbria University leading this pilot have devised a tool known as 'Creative Tensions' [10] that allow workshop participants to rapidly assimilate stakeholder concerns in a given situation. They offer a way of representing a Problem Space as a set of exaggerated statements positioning perspectives relating to a situation or circumstance to bring the problem to life. Typically, the workshop facilitators prepare these template-based statements in advance. However, in this case, in order to truly represent the voice of graduates, the team chose to work with the participants in the days prior to the workshop to develop these tensions themselves.

The themes that the group developed were: Communication; Time Management (organisation); Flexibility; Organisational Culture (team working)

3.1 Workshop plan

The workshop was planned thus:

A multidisciplinary group of postgraduate students studying for a degree in innovation would be the participants facilitated by the staff that regularly teach them. They would work as a large group for the first and final activities and in smaller sub-teams for the intervening activities.

- **Set-up** – participants were to be provided with links to the various resources that the collaborating partners had provided two days before the event. These comprised predominantly articles from popular press, specialist media and TED talks.
- **Session 1 - Problem-framing**
  - Briefing – context setting, share Creative Tensions and establish six sub-teams
  - Activity 1: Learning Journeys – work in small groups to map learning journeys relative to each theme: what was learned, how and where; how it was assessed and recognised
  - Activity 2: Adapted World Cafe approach. Rotate from theme to theme using the Creative Tension as a prompt to ask 'what if universities did…' questions building upon the ideas of participants who have already contributed to this theme
  - Activity 3: Sum-up – what were the really interesting, novel or fragile ideas upon which we can build? What have we missed?
- **Session 2 - Solution development… Shhh it's a secret!**
  - Advise teams that for the forthcoming activities they will work 'in secret', hiding their ideas from the other teams
  - Activity 1: Synthesis - for each tension, translate the most compelling combination of 'what- ifs' into propositions
  - Activity 2: Wildcard – two unexpected contextual changes presented at random to each team with the purpose of provoking broader consideration of the emerging intervention and to aid decision making
- **Session 3 - Solution development 2… Shhh, it's still a secret!**
  - Activity 1: Create, test (through devil's advocacy questioning) and re-create refined learning journey for new proposition using the same format adopted in problem-framing. Consider this from each stakeholder perspective
- **Session 4 - Reveal, combine and communicate**

- Activity 1: Reveal - pitch the six interventions to each other, elicit questions and feedback
- Activity 2: Combine and refine the six interventions into a proposition
- Activity 3: Create a single proposition pitch
- Activity 4: Deliver the pitch

- **Session 5 - Reflection**
  - What did we learn about the topic?
  - What did we learn from the approach?
  - What can be done differently in the future?

4 WORKSHOP EXECUTION

4.1 Problem-framing

The Problem-framing sessions ran broadly as planned with two significant differences. Firstly the facilitators recognized that, having been involved in the creation of the themes and corresponding Creative Tensions, the participants were immersed in the problem-space before starting the workshop. In order to energise the group and freshen-up their thinking, a list of '10 skills employers say they seek' and a separate list of 'soft-skills' were given to the participants to consider in combination with the Creative Tensions. Secondly, after two rounds of the World Café activity, the facilitators saw that the participants were stagnating and repeating ideas they had used in the previous round. Consequently for each subsequent round a slightly revised challenge was put to them: 'What is the best idea on the table? Build on this'; 'What would make a reluctant student say 'yes'?' etc.

4.2 Solution Development

The Solution Development sessions followed the planned structure. Working 'in secret' added a focus to the participating groups' activities. However it was necessary for the facilitators to adapt to the ideas and activities that were being developed. Whilst the groups were all eventually able to synthesise the most promising ideas into preferred propositions, they had to be prompted to remember the key skills list to aid them in decision-making. The main adaptation required at this stage was relaxing the requirement to use the Learning Journey model viewed from different stakeholder perspectives. This was necessary for two reasons. Firstly, some of the interventions being proposed were higher-level thinking than could be reasonably expressed through a learning journey. To impose this restriction would have closed-down the expansive thinking of the teams involved. Secondly, throughout the exercise the majority of participants found it difficult to adopt the employers' perspective. For these reasons, the teams were allowed to deploy different means of envisioning their intervention.

4.3 Reveal, Refine and Communicate

For the final Reveal, Refine and Communicate session the facilitators decided that it was necessary to change direction more radically. In the planning they had envisaged that a single, coordinated and integrated proposition could be drawn together from the separate teams' propositions. It was anticipated that, by keeping their ideas secret from each other, the Reveal activity would elicit incisive questions and constructive feedback based upon what was presented rather than what was assumed or had been assimilated had the activity been open. This was indeed the case. However, what became very clear to the facilitators was that, having been afforded such an open brief and open approach to envisioning, it would have been too difficult and contrived to force-fit the six interventions into one solution within the available time without losing some of the more challenging and fragile (but inspirational) ideas. For this reason the teams were given an hour to sharpen their individual propositions based upon the critical feedback and questions shared during the Reveal.

4.4 The resulting interventions

Six interventions, derived from the original themes were proposed as follows:

- Initiative: a web-based platform that capitalises on millennials' entrepreneurial mindset by providing a safe-space for student/industry project-based collaboration
- Work Ready Me: a university/industry collaboration through which gap-years that promote and recognise competency development are delivered.
- Co-versities: a university/industry team-based collaboration that delivers learning about culture within organisations - they exist for the benefit of both students and the businesses and have multiple global sites providing innovation-hubs and peer-to-peer learning.

- Personal Development: delivered through a life-long learning fund and academics who no longer work in universities but sell their teaching through a web-based platform.
- Learn Communication, Achieve Impact: delivered through community impact via 'Communi- care', a system by which students learn all about communication whilst developing and delivering social benefit through working with local charities.
- Uncertain Spaces: (developing flexibility) the university as a bridge between employer, student and the old job roles that will be taken by robots (medicine, law, management) and the new (creativity, innovation, design, engineering...) achieved by establishing ambiguous physical environments without rules and conventions in which students collaborate with employers.

These were presented to senior academics from Slovenian and South Korean partner institutions and their observations form part of our discussion.

4.5 Reflection

As a means of ensuring that both students and academics benefit from maximum learning from each project, it is customary for the academics who led this activity, to hold a reflection session immediately on its conclusion. In this case, whilst the reflection session did address what they had learned about the topic we will concentrate here on what was learned from the approach (the workshop design) and what, from their perspective, might be done differently. There were four main reflections:

1. Resources: the participants didn't engage fully with supplied material prior to the event and would have preferred this summarised within the brief at the start of the event.
2. Creative Tensions: for these to be truly effective, they need to represent multiple different perspectives for each theme.
3. Employers: the graduate talent voice was well represented within the event, as was the university perspective (through the facilitators) but more authoritative employer perspectives were missing.
4. The introduction of Wildcards was seen as positive, but they weren't universally helpful: in many cases they aligned too easily with emerging propositions so it was easy to incorporate them.

Furthermore the participants highlighted a number of aspects that they found particularly helpful: structure and facilitation; the use of templates; the use of learning journeys (although they commented that these need to form a strong theme throughout the whole workshop); maintaining secrecy which encouraged productivity and trust.

5 DISCUSSION

Through the Reflection session and discussion with our overseas partner academics we have arrived at a number of discussion points that need to be considered when refining the workshop design for future use in other locations if it is to make a useful contribution to the overall GETM3 research. Firstly, we must consider the points raised by the students during the Reflection session each of which is relatively straightforward to remedy through refining the pre-prepared resources and templates involved in facilitating the workshop.

Predominant amongst further considerations is the fact that these participants were all of a creative mind-set, they were familiar with working in teams, engaged in enquiry-led cooperative learning using Design Thinking to address challenges posed to them by potential employers, albeit they had only been experiencing this for one semester. Coupled with the fact that they were involved in determining the Creative Tensions and themes, this makes their suitability for a pilot study somewhat questionable. Indeed, in a number of cases, the teams arrived at proposed interventions that mimic the Masters degree they are currently studying for. A typical cohort when the finalised workshop is deployed is more likely to comprise students with backgrounds in business studies, the humanities and social sciences and the authors need to be mindful that greater encouragement and facilitation will be required. However, there is potential that these participants will present a more diverse range of interventions due to their different experiences and their unfamiliarity with Design Thinking.

Whilst the participants represented very diverse cultural background and prior HE learning experiences, our overseas colleagues suggested that we may need to tune the workshop to satisfy local cultural differences. For example, it was suggested that in one of the partnering countries, for example, an instruction to work in secret would in fact encourage students to do the opposite! Implicit in this is a need to engage with local academics in refining the workshop design for use in each setting.

The themes, Communication; Time Management (organisation); Flexibility; Organisational Culture (team working); Personal Development and Work Experience, and the interventions that the students produced reinforce the inference drawn in the introduction to this study because the themes correspond broadly with the top skills required/delivered through design education and the interventions tend to be dependent on the sort of pedagogies highlighted by Shreeve et al [ibid]. However, the participating cohort were desensitised to the novelty of the design education approach and it will only be through running subsequent workshops with cohorts without such experience that the authors can start to evaluate a, whether they learn anything relevant to the employability skills from being exposed to design education approaches adopted in the workshop and b, whether the themes and interventions they create reinforce or contradict what the study infers.

6 CONCLUSION

The pilot study provided valuable insights that will inform future iterations of the workshop. The format was enabled students to work together employing Design Thinking approaches to explore the wicked problem of what and how universities should teach in order to equip graduates with the skills that employers are likely to seek even when the job role is yet to be defined. The pilot was useful in helping the authors refine the workshop design for subsequent use with more diverse cohorts. The pilot participants came up with themes and interventions that support the idea that a design education approach could be effective in delivering these skills. However, the creative disposition of the pilot cohort and lack of a more authoritative employers' voice highlights the need to deploy the refined workshop with multiple 'non-design' cohorts and employers in order to start to draw firm conclusions.

REFERENCES

[1] Niederhelman, M. Education through design. *Design Issues*, 2001, 17(3), 83-87.

[2] *Report of The Future of Work Commision, Executive Summary.* Available at: https://d3n8a8pro7vhmx.cloudfront.net/campaigncountdown/pages/1052/attachments/original/15 12946217/Executive_Summary_Future_of_Work Commission_report_December_2017.pdf?15 12946217/ [Accessed on 2018, 19 February], (2017). Website.

[3] Ball, L., Pollard, E., and Stanley, N. *Creative graduates, creative futures*, 2010 (Council for Higher Education in Art and Design, London).

[4] Bridgstock, R. and Cunningham, S. Creative labour and graduate outcomes: implications for higher education and cultural policy. *International journal of cultural policy*, 2016, 22(1),10-26.

[5] Shreeve, A., Sims, E. and Trowler, P. 'A kind of exchange': learning from art and design teaching. *Higher Education Research & Development*, 2010, *29*(2), 125-138.

[6] Wastell, D., Archarios: A dialogue between Socrates and a novice manager on the relevance of design to management practice and education. *Academy of Management Learning & Education*, 2014, 13(4), 641-652.

[7] Glen, R., Suciu, C. and Baughn, C., The need for design thinking in business schools. *Academy of Management Learning & Education*, 2014, 13(4), 653-667.

[8] Brown, T. *Change by design: how design thinking transforms organizations and inspires innovation*, 2009, (Harper Business, New York).

[9] Elmes, J. *Times Higher Education.* Available at https://www.timeshighereducation.com/news/martin-boehm-preparing-students-for-jobs-that- dont-exist-yet [Accessed on 2018, 24 January], (2017) 25 February. Website.

[10] Sterling, N., Bailey, M., Spencer, N., Lampitt Adey, K., Chatzakis, E. and Hornby, J. *From conflict to catalyst: How can a design-led approach use critical human conflicts within collaborative and co-creative innovation practice?* 2018, Unpublished.

Publication 6

A Design-Led Approach to Transforming Wicked Problems into Design Situations and Opportunities

This double-blind, peer reviewed article, published in The Journal of Design, Business and Society, builds on the application of design in an expanded field as it presents a case study of design-led innovation in the context of a cyber-crime project. It establishes six 'enablers' which support the growth of creative confidence amongst non-design stakeholder participants.

The significance of this work to this submission is that it demonstrates the integrated role of actions, actors and attitudes (presented in the article as 'enablers') in the development of new knowledge for the project situation, about the methods and tools of design and for individuals as they transition from expert participant to co-creation activist, .

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A design-led approach to transformingwicked problems intodesign situations andopportunities

ABSTRACT

This article argues that using a design-led approach is highly beneficial when tackling complex problems to transform ambiguity into actionable design briefs and solution opportunities. This is evidenced by way of an ongoing project with a large public-sector organization. Northumbria University's School of Design academic experts use design-led approaches to innovation that promotes 'crea- tive fusion' between diverse stakeholders in order to tackle 'wicked problems'. The authors continue this work as part of an Arts and Humanities Research Council/ European Regional Development Fund-funded programme entitled Creative Fuse North East (CFNE), involving five regional universities, of which the project discussed here is a part. The main objectives of CFNE are to develop and deploy approaches to innovation that apply skills from creative graduates to benefit the wider creative economy, address barriers to innovation and promote growth and sustainability within and without the Creative, Digital and IT sector (CDIT). The authors propose that to do this it is vital to convert stakeholders into co-creation activists empowered with the creative confidence and tools required to speculate about uncertain futures.

KEYWORDS

design
catalysts co-creation
frames
multidisciplinar y
creative confidence
innovation

1. Introduction

Society faces increasingly ill-defined, networked, dynamic and seemingly intractable problems (Dorst 2015). Such problems have been termed 'wicked problems' (Rittel and Webber 1973). Wicked problems require specific working practices to frame and address them since 'we are at a critical point where rapid change is forcing us to look not just at new ways of solving problems but to new problems to solve' (Brown and Katz 2009: 153). We cannot achieve this in isola- tion as individual knowledge can only be partial (Russell 2010). Rather, collective wisdom from multiple disciplines must be directed towards a common purpose, tackling the wicked problem. Furthermore, methods of inquiry and decision- making need to be flexible so that one can remain open to revisions in response to new information (Russell 2010). It is not straightforward to work collaboratively within ambiguous and complex spaces such as these. Collaborators and stakeholders can bring conflicting requirements and their personal or institu- tional perspectives to collaborations (Brown 2010; Dorst 2015) and uncertainty can be uncomfortable. Here, a design-led approach can be invaluable (Kyffin et al. 2017). Through the use of design, it is accepted that problem and solu- tion understanding co-evolve whilst addressing complex, ill-structured, wicked problems (Dorst and Cross 2001). This is particularly relevant when the topic under investigation is new and dynamic as in this case study presented.

A design-led approach has been argued to offer a holistic way to tackle wicked problems (Hocking 2010; Lam 2017). When applied during 'problem framing' (Dorst 2015), it can transform seemingly intractable, complex prob- lem spaces into actionable briefs and solution opportunities that bring clarity, meaning and direction (e.g. Wrigley 2017; Gulari and Fremantle 2015; Innovate UK 2015; Bucolo and Matthews 2011) and social innovation (e.g. Nusem et al. 2017; Brown and Wyatt 2010). Often, the special way that designers think and do things is cited (e.g. Dorst 2011; Beckman and Barry 2008; Cross 2006).

This can be captured as a working practice involving flexibility and action.

For example, Hocking describes designers as considering:

> questions about what could, should or ought to be […] through the ability to enact knowledge in an iterative process where the identity of the designer is central and the paths they follow have dynamic variability […] characterized by playfulness and praxis, bridging knowledge and action. (2010: 244)

These abilities are employed strategically within organizations to enable them to: identify emerging opportunities; investigate and visualize how issues are interconnected; frame focused questions to tackle the core issues; and collab- orate with diverse disciplines through design-led methods and tools (Lam 2017; Price et al. 2013). It could be argued that Hocking's (2010) 'identity of the designer' should be replaced by the 'designerly purpose', identified by Bailey et al. (2014), which focuses on the particular values that drive the individual designer's actions. Indeed, we see the emergence of the importance of the common (designerly) purpose of the team (Spencer et al. 2017). This change reflects the importance of co-creation, evidenced in this article by way of the Creative Fuse North East (CFNE) action research programme's case study project that employs an innovation approach previously termed as 'creative fusion' (Sapsed et al. 2013).

The case study in question addresses the complex, wicked problem of cybercrime vulnerability. In this case study, the team[1] have enabled people

1. Collectively known as 'the team', Northumbria University's CFNE team consists of design-led innovation academics, researchers and IiRs – recent master's graduates who support the projects whilst being mentored by the NU as they launch their own businesses.

to work together in this uncertain and complicated environment in order to reach strategic solution opportunities. This has been achieved through facili- tating those who may not feel comfortable with ambiguity to welcome it and encouraging people to bring ideas to life in ways that encourage speculation and 'what if?' questions (Coyne 2005).

2. Context: A design-led approach to facilitation, co-creation and problem framing with multidisciplinary teams

Multidisciplinarity offers a breadth of knowledge and perspectives that helps produce multiple opportunities and solutions (Alves et al. 2007). A meaning- ful multidisciplinary collaboration enables teams to be more than the sum of their parts and achieve things they could not have if working individually. Amongst other benefits, multidisciplinary teams can act as 'outsiders' to each other to identify and question assumptions (Nissani 1997). Through collab- oration, previously separate concepts, expertise, products or services may be united in new and unexpected ways to create innovative solutions (Fong 2003) and 'new ways of thinking, communicating and working' (Bailey et al. 2013: 12–13). These are not new ideas, but they remain pertinently evidenced in, for example, policy-making (see Department for Business, Energy & Industrial Strategy 2017).

Hand-in-hand with a multidisciplinary approach, the authors advocate an inclusive process, where stakeholders are actively involved as experts during problem framing and co-creation activities (Broadley et al. 2016; Björgvinsson et al. 2010). Co-creation is a broad term, but can be defined as two or more people working creatively in collaboration (Sanders and Stappers 2008). This approach is based on the principle that everyone, with the right facilitation, can be creative (Sanders and Stappers 2008).

Multidisciplinary co-creation presents challenges, especially when work- ing with 'wicked problems' and this may be heightened when participants come from different backgrounds. Teams need to build trust (Broadley et al. 2016), identify a common purpose (Spencer et al. 2017), and find effec- tive ways to communicate and generate a collective knowledge base (Sanders and Westerlund 2011). Furthermore, roles must be clarified (Facer and Enright 2016) and conflicting perspectives managed (Björgvinsson et al. 2012b). Therefore, collaborations require facilitation as people may not have worked in this manner before and, as Sapsed et al. postulated, 'people live and social- ize in unfused professional, disciplinary and social communities. When these different cultures are brought together, it often exposes cultural mismatches rather than creative opportunities' (2013: 68).

Particularly relevant to this article are recent proponents of using design- ers to instigate and facilitate collaborations, for example calls from industry (Design Council 2015; Bucolo and Wrigley 2014; Fraser 2012; Liedtka 2011; Verganti 2009) and academia (Wrigley and Straker 2017; Bowen et al. 2016; Sanders and Stappers 2008). A design-led approach to co-creation (Davis et al. 2016) includes activities that encourage participants to (amongst other things):

- visualize information to enhance understanding and communication (Schoffelen et al. 2015);
- make physical things to make sense of the problem space and prototype ideas (Sanders and Stappers 2014; Vaajakallio and Mattelmäki 2014);

- look at issues from different perspectives, for example through storytelling (Bornet and Brangier 2016; Nusem et al. 2013);
- engage with ideas in a meaningful and playful way (Björgvinsson et al. 2012a; Gray et al. 2010).

A design-led approach can be used to address challenges associated with multidisciplinary co-creation and ensure groups arrive at implementa- ble outcomes (Norman and Verganti 2014; Bucolo et al. 2012). Moreover, a design-led approach helps collaborators to accept the inherent ambiguity in the imperfection of wicked problems through activities which frame ambigu- ity positively as a space for speculation (Dorst 2015). Being prepared to specu- late and build a deeper understanding is a key capability within design and innovation practice (Sanders and Stappers 2014; Buchanan 1992). By employ- ing designerly methods, these speculations can be brought to life in physical, visual or narrative forms. Generating multiple potential speculations and solu- tions both develops the team's understanding of the problem, i.e. 'framing' it, and facilitates refinement of the most promising solutions into viable proposi- tions (Boer and Donovan 2012; Bucolo et al. 2012). Problem framing involves collecting perspectives from stakeholders, systematically visualizing and inter- rogating this information, and then using it to generate more pertinent and strategic questions (Lam 2017; Buchanan 1992). One aspect of this is balanc- ing goal-orientated and experimental activities (Lam 2017). De Mello Freire (2017) frames this as pursuing non-linear thinking (characterized by changing circumstances, multiple parts and adaptability) in a manner that is beneficial rather than detrimental to linear thinking. This activity may appear chaotic and undirected (Sanders and Stappers 2008). Nevertheless, there is an overall trajectory towards more definable and actionable briefs and solution opportu- nities. It is this trajectory that this article explores.

In the fields of psychology and behavioural studies, both problem-focused and solution-focused approaches are explored in relation to goal-oriented activities. Bandura (1982) establishes the concept of self-efficacy in pursuit of self-determined goals and Kelley and Kelley (2013) draw an important comparison between self-efficacy and creative confidence. Concluding this article, we consider the implications of adopting a more optimistic mind-set in problem and solution-framing that builds on this psychological perspective. The evolving role of design and design-led, or design-infused (Myerson 2018), innovation is increasingly highlighting a bifurcation of applica- tion: 'design execution' – using the designers knowledge, technical skills and craft to make manifest tangible products, systems and services and 'facilitation by design' – using the designers' 'soft-skills' and curiosity, coupled with care- fully crafted, tailored resources to facilitate creative knowledge sharing and generative co-creation within teams of 'non-designers' (Krabye et al. 2013).

Such skills and resources may be termed *enablers*.

3. A conceptual framework

Co-creation at Northumbria University (NU) is grounded in design practice and supported by business knowledge. It uses strategic, creative and gener- ative methods to frame problem and solution spaces that co-evolve with design facilitation to encourage innovation. Like many design innovation models, NU's approach involves several divergent and convergent activities in order to gain understanding, generate knowledge, establish empathy with

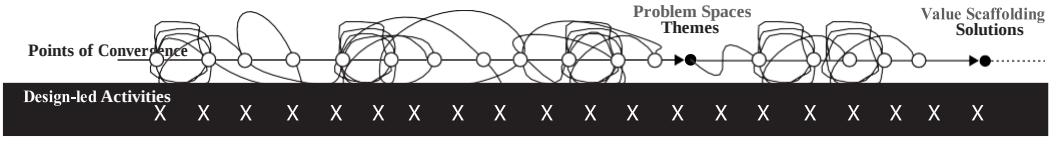


Figure 1: Illustration of the co-evolution and iterative process of the problem and solution framing across a project journey.

stakeholders, and build trust and creative confidence in activists with different interests and roles within the project. At points of convergence, new themes and patterns emerge leading to new ideas. These act as value scaffolders for creative briefs and strategies, and as common ground around which diverse stakeholders can converge. As seen in Figure 1, this approach follows an iterative process of X number of activities that vary according to the project needs. This allows a set of core resources/activities to be adopted, adapted and deployed at different points in a project journey.

The 'designerly' ways in which the team at NU facilitates this way of work- ing can be summed up by six 'co-creation enablers'. These are presented below and further build on the relevant literature discussed hitherto.

3.1. Enabler: Environment

The importance of creating an appropriate and supportive environment for innovation has been covered extensively (e.g. Dombrowski et al. 2007). Likewise, many design thinking proponents discuss appropriate spaces, both physical and mental, that can enable and facilitate multidisciplinary collab- oration (e.g. Brown and Katz 2009). Often features such as flexible (chang- ing according to project needs), open and dedicated project spaces, equipped with creative resources to enable reflection and visualization are cited as key components of environments that foster collaboration and innovation (Davis et al. 2016). Co-creative environments must ensure that they are inclusive
i.e. all voices are equally heard (Fremantle et al. 2016), and they are not built on hierarchy but on a shared control and ownership manner (Bødker 1996). At NU, such a 'safe' environment is created which includes both appropriate physical space and resources, and a supportive non-judgemental intellectual and visceral space for open engagement (Bailey and Smith 2010).

3.2. Enabler: Participation

Finding appropriate means for involving stakeholders from different back- grounds, interests, experiences and roles is a key challenge in every co-creation activity (Schoffelen et al. 2015). Whilst establishing a network of stakehold- ers to contribute diverse knowledge and expertise is needed it is equally important to ensure the right conditions are in place to enable meaning- ful and active participation (Broadley et al. 2016; Bødker 1996). This enabler, therefore, is concerned with creating the right conditions for participants to act both as *experts* (i.e. share knowledge and expertise) and as *activists* (i.e. actively involved in co-creation activities) with an enhanced sense of empow- erment and ownership during project activities. This needs to be nurtured in each participant in order that they are supported to develop their individual, and thereby the group's, creative confidence: 'the ability to come up with new ideas and the courage to try them out' (Kelley and Kelley 2013: 6).

3.3. Enabler: Structure

Traditionally, co-creative and participatory design activities are practised through some form of workshop with 'predefined staged settings in which people gather for specific design purposes and are supported by a specific structure and design tools' (Schoffelen et al. 2015: 180). However, when work- ing on dynamic wicked problems, NU's model advocates an approach that, rather than being a prescriptive toolkit, is also dynamic; confident, deliber- ately semi-structured and open to change as circumstances change and ideas develop.

3.4. Enabler: Attitude

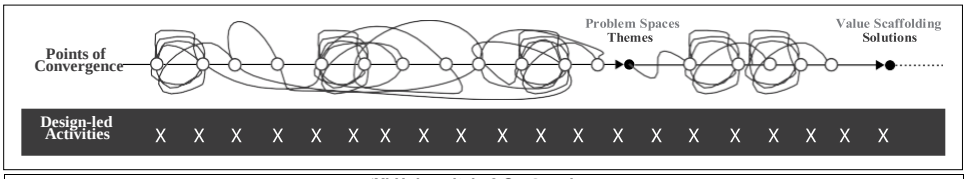
The nature of work within the design discipline is often characterized by a set of 'design attitudes' (Michlewski 2016) such as embracing ambiguity and complexity, being open and questioning, engaging deep empathy, and bring- ing things to life through making. When working with non-designers, these attitudes may differ significantly; often, there is lack of mutual understanding of the situation, lack of trust, different world-views, motivations and so forth (Broadley et al. 2016). NU's approach facilitates a 'designerly' attitude based loosely on Sinek's (2011) 'why, how and what' questions. However, critically, these are accompanied by 'what if?' questioning in order to generate provoca- tive speculations as the genesis of concepts (Bailey et al. 2013).

3.5. Enabler: Visualization

An important aspect in co-creation and participatory design practice relates to the adoption of appropriate tools that are used by both designers and non- designers to facilitate reflection, imagination and expression of visions, ideas and concepts (Sanders and Stappers 2014). Like the open and flexible envi- ronment and structure discussed earlier, a range of design-led tools (including mapping, sketching, prototyping, storytelling, etc.) are used to translate 'what if?' questions into tangible forms to aid communication, sense-making and reflection (Schoffelen et al. 2015; Björgvinsson et al. 2012b). These co-creation tools are bespoke and tailored to the needs of each particular project activ- ity whilst purposefully designed to foster a playful, exploratory, imaginative, dialogical and empathetic mindset (Vaajakallio and Mattelmäki 2014).

3.6. Enabler: Agents

Within innovation, business and entrepreneurship literature, the presence and role of 'innovation champions' is cited as a key catalyst to business success and innovation (e.g. Rogers 2003). Such champions have been defined by Jenssen and Jörgensen (2004: 65) as 'an individual that is willing to take risks by enthusiastically promoting the development and/or implementation of an innovation inside a corporation through a resource acquisition process with- out regard to the resources currently controlled'. More recently, Wrigley (2016: 151–52) introduced the term 'design innovation catalyst' to describe the key individuals whose role is to 'translate and facilitate observation, insight, mean- ing, and strategy', engage and involve many different internal and external stakeholders, and iteratively prototype solutions and form value propositions for the organization. NU's approach celebrates such roles through a combi- nation of experienced design-led academics and multidisciplinary innovation



'X' University's 6 Co-Creation Enablers	
Environment	A safe environment is created which includes both appropriate physical space and resources, and a supportive non-judgemental intellectual and visceral space for open engagement (Bailey & Smith, 2010).
Structure	A confident, deliberately semi-structured approach is taken which is open to change as circumstances change and ideas develop.
Participation	Establishing and engaging with a network of stakeholders to contribute diverse knowledge and expertise. Participants include experts (who contribute knowledge) and activists (who are involved in co-creation activities) indeed partici- pants may be both.
Attitude	An open and questioning attitude (Michlewski, 2015) is facilitated based loosely on Sinek's (2011) 'why, how and what' questions. However, critically, these are accompanied by 'what if?' questions in order to generate provocative speculations, the genesis of concepts (Bailey et al., 2013).
Visualisation	A range of tools used to translate 'what if?' questions into tangible forms to aid communication, sense making and reflection (Björgvinsson et al., 2012b; Schoffelen et al., 2015).
Agents	Students are catalytic agents in a problem situation due to their 'creative naivety' (Bailey, Aftab, & Smith, 2015) - they are curious and knowledgeable, and give 'professionals' permission to work creatively and ask naive questions which often challenge company-held perceptions and preconceptions around the problem space.

Figure 2: Northumbria University's conceptual design-led innovation framework.

students. The students' role is particularly vital in the approach (Morehen et al. 2013). They act as catalytic agents in a problem situation due to their 'crea- tive naivety' (Bailey et al. 2015) – they are curious and knowledgeable, and give 'professionals' permission to work creatively and ask 'dumb' questions which often challenge company-held perceptions and preconceptions.

Application of these enablers (Figure 2) will be traced through the case study. This serves to demonstrate some of the highly beneficial ways a design- led approach can help frame wicked problems through facilitating meaningful collaboration and co-creation between people from diverse backgrounds.

4. Research aims

As part of the CFNE action research programme, the team set out to develop and deploy approaches to innovation that apply skills from crea- tive graduates to benefit the wider creative economy, address barriers to innovation and promote growth and sustainability within and beyond the Creative, Digital and IT sector (CDIT). The research aim set out in this arti- cle was to test NU's design-led innovation approach as an effective way to convert stakeholders into co-creation activists empowered with the creative confidence and tools required to address wicked problems and speculate about uncertain futures. Therefore, the research questions set out to explore through this case study were:

1. How do 'co-creation enablers' support stakeholders, unfamiliar with crea- tive and collaborative practices, to acquire the necessary creative confi- dence needed to become co-creation activists?
2. Are design-led methods and approaches an effective way to transform highly complex, 'wicked' problems into a set of actionable design briefs that can increase the potential for meaningful innovation?

4.1. Research methodology

A case study research methodology (Yin 2014; Gerring 2007) over a single case design (Flyvbjerg 2011) has been used. Case study research is an empirical method of enquiry that seeks to investigate in-depth phenom- ena situated within real life settings. The article focuses on a single case study in order to observe and explicate phenomena associated with particu- lar activities taking place within a specific situation and context. The study adopted a phenomenological approach where both the researchers and participants were part of the context being studied (Flyvbjerg 2011) and co-creators of meaning (Robson 2002). According to Flyvbjerg (2011: 304), a single case study is an adequate unit of analysis insofar as the case has been strategically chosen. This article adopts a paradigmatic case choice which is appropriate for representing a given practice and school of thought by highlighting its characteristics and offering a 'practical prototype' as refer- ence points to its function (Flyvbjerg 2011: 307). Moreover, this approach allowed the researchers to achieve a thorough understanding of both context and process as well as linking causes and outcomes to the observ- able phenomena.

4.2. Methods of data collection

Primary data was collected on the process, methods, tools and approaches utilized and a rich collection of project collateral generated by the team and project participants was reviewed. Analysis of data focused on finding the extent to which the design-led activities, tools and methods were effective means for bringing diverse stakeholders together and empowering them actively to co-create problem and solution frames. This data was supple- mented by an action research approach based on the authors' active involvement, facilitation and observations made throughout the duration of the project. This research approach was appropriate to the needs and purpose of this study because it built upon 'the natural process of planning, acting and critically reflecting on the results – bridging the gap between practice and theory' (Wrigley 2017: 6).

5. Raising awareness and changing behaviour: From a wicked problem to actionable solution opportunities in cyber security

Earlier, we proposed six co-creation enablers that support people as they move a wicked problem space from a position of ambiguity to one where there are strategic and actionable solution opportunities. This is evidenced and explored further here by way of the following case study which analy- ses a programme of activity undertaken through the aforementioned CFNE programme. The project responded to challenges associated with digital policing practices around cybercrime and cybersecurity. This challenge is a truly dynamic wicked problem; it is large in scale, involves multiple stake- holders and is ill-defined, for example key factors are rapidly changing and difficult to clearly establish.

The project involved thirteen key design-led activities, labelled here with a letter (A, B, C, etc.). A summary of activities A to M is depicted in the project

journey timeline below (Figures 3 and 4). The case study represents three core phases of activity which we detail in the following sections:

- Project establishment and initiation, which involved the core NU academ- ics and researchers along with partner institution academics, Northumbria Police and innovators in residence (IiRs) (Activities A and B).
- Student-led project, which involved the multidisciplinary innovation (MDI) students, supported by NU academics and IiRs working with multi- ple different stakeholder groups (Activities C to L).
- Analysis and recommendations, which involved NU academics, IiRs and Northumbria Police (Activity M).

5.1. Project activities

5.1.1. A: What is the problem?

In order to promote 'creative fusion', CFNE established regular regional networking events under the banner of 'CAKE' – Collaboration And Knowledge Exchange. These semi-informal sessions brought together a diverse community of academics and businesses. At one such event, a repre- sentative of Northumbria Police attended out of curiosity and hoping to discover how working with local digital and creative businesses might lead

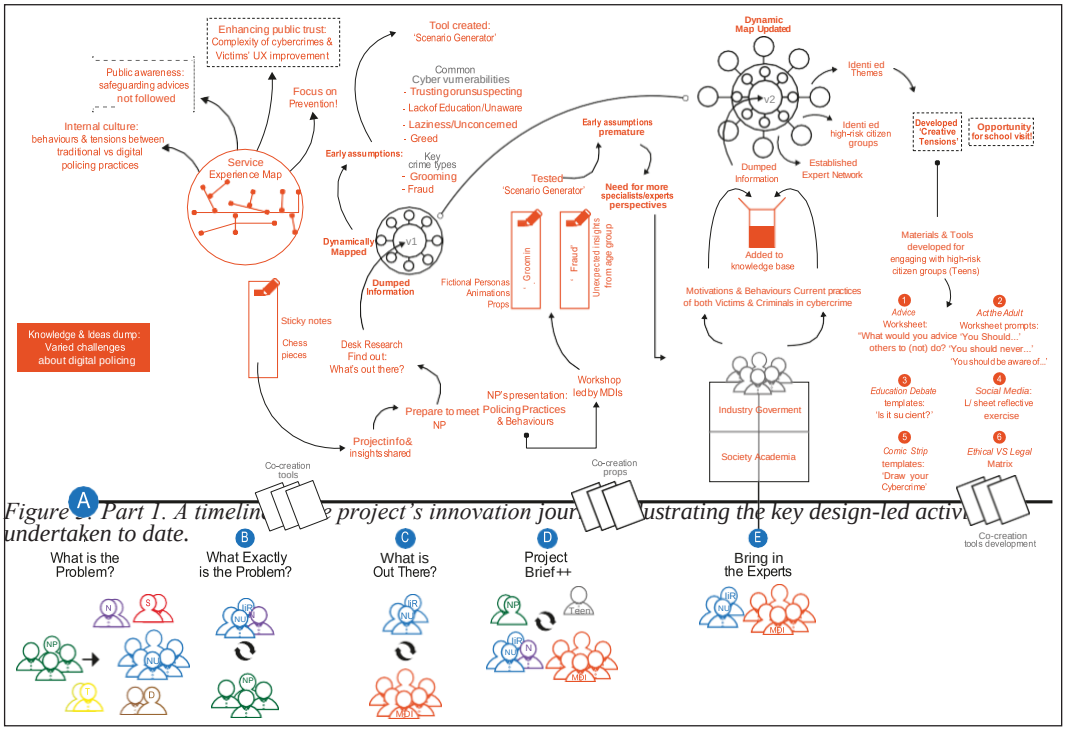


Figure 3. Part 1. A timeline of the project's innovation journey illustrating the key design-led activities undertaken to date.

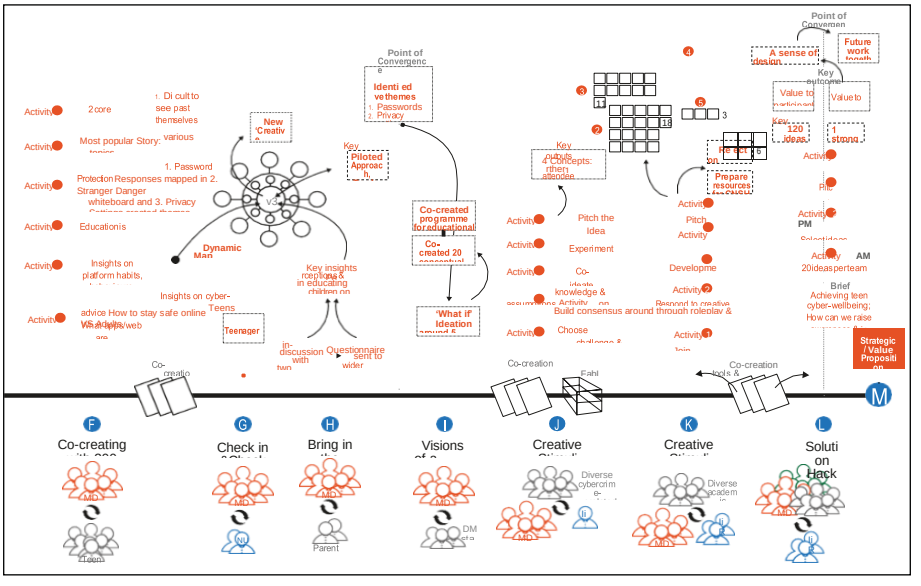


Figure 4: Part 2. A timeline of the project's innovation journey, illustrating the key design-led activities undertaken to date.

to development of digital applications to assist in addressing the challenges posed by cybercrime. This combination of curiosity and need represented fertile ground for a trusting relationship to be established.

During facilitated preliminary discussions with Northumbria Police and the five CFNE University partners, police representatives highlighted areas of cybercrime policing that they saw to be key concerns. These included cybercrime prevention, engaging with local software developers, tech- nology horizon-scanning, to issues with investigation, such as improv- ing internal communications within the police. Important at this stage in discussions was an honest admission from the CFNE University partners that they had no idea where the project would go, what the end results might be, nor a great deal of detail about how the project might progress. However, NU's team were confident that they would be able to establish some new ways of thinking and working that would reveal new knowledge for Northumbria Police. A number of discussions were required to establish trust and secure the project. The X team proposed to change the focus of the project to 'behaviour-change' and to consider ways to tackle unsafe digital practices (e.g. leaving Bluetooth on, not applying privacy settings or install- ing updates). The project goal was to co-create design proposals with CDIT businesses, students, academics and Northumbria Police staff which could then be developed further in the future.

5.1.2. B: What exactly is the problem?

This two-hour session aimed to find out more about the challenge as perceived by the problem-owners. The team's key objective was to foster mutual under- standing around the challenges. This was done through questioning and exploring the context in which the problem exists, relevant stakeholders and any established assumptions.

Northumbria Police were not familiar with the creative nature of the session and therefore the space was curated in order to make it interactive and engaging. For example, the team strategically removed all seating from the room with the aim that attendees would spend their time 'doing'. Desks were dressed with large sheets of paper and various co-creation resources such as multicoloured marker pens, sticky notes and chess pieces (to indicate hierar- chy). Tea, coffee and chocolate fuelled the creative thinking.

In order to better understand the problem space, generative participatory techniques were used to facilitate conversations, capture insights and enable participants' discourse and reflection. Storytelling is a valuable tool in design-led innovation (Parkinson et al. 2012) as it is in policing and investigation – taking and analysing a witness statement is familiar for police personnel. This aware- ness was used to design co-creative activities that facilitated story-making as a means of uncovering knowledge. The structure was intentionally open and the police were asked to identify a pertinent cybercrime scenario and describe how the event unfolded. Using a derivation of a service mapping exercise, partici- pants co-created a process/experience map that visually articulated the issues and challenges of digital policing in this scenario, answering why, how and what was going on (Figure 5).

It became apparent that cybercrimes can be perpetrated from anywhere in the world and are, therefore, difficult to solve. This resulted in Northumbria Police's focus being on prevention to explore how best to educate the public about how to better protect themselves online. Whilst, with hindsight, this might seem like an obvious observation, it is essential to the establishment of trust and buy-in that participants are able to see that they are instrumen- tal in arriving at insights and developing solutions. Northumbria Police felt that their previous efforts in educating the public had been largely unsuc- cessful and therefore it was clear that innovative approaches were required. The 'swamp of data' (Spencer et al. 2017) that resulted from the mapping exercise was filtered into actionable issues which revealed three intercon- nected 'cybercrime' challenges:

1. Raising public awareness about cybersecurity: Northumbria Police has found that citizens and businesses do not follow data safeguarding advice resulting in avoidable cybercrime.
2. Enhancing trust between the public and the police: This could be done by improving public understanding of digital policing practices and processes, e.g. by communicating the complexity of cybercrime and improving victim's experiences during cases.
3. Internal culture: Different practices and attitudes within traditional and digital policing create tensions that result in slow responses to cybercrimes.

After the first creative problem framing session, the team proposed an initial project plan entitled 'Cybercrime: Public awareness and behaviour- change'. The project aimed to develop early-stage concepts or solution

2. MDI students are, hereafter, referred to as 'the students' whilst other students engaged in the project as participants are referred to as 'student participants'.

Figure 5: A snapshot of co-creation activity during a creative problem definition session with the problem owners.

opportunities using preparatory design work and a series of co-creation prob- lem framing and definition sessions involving diverse stakeholders. Solution opportunities would then be developed into working prototypes by CDIT businesses. To support this preparatory work, the team engaged six postgrad- uate students of MDI[2] (Bailey and Smith 2010), as catalytic agents for new thinking.

5.1.3. C: What is out there?

After being briefed on the project the students were asked to familiarize themselves with the problem space. In order to document and reflect upon their secondary research the students used a variation of a dynamic stake- holder mapping tool (Knowles and Spencer 2016). This stage resulted in initial evidence regarding common cyber-vulnerabilities (e.g. 'trusting or unsuspect- ing', 'uneducated or unaware', 'lazy or unconcerned') and two key cybercrime types, grooming and fraud. Based upon these insights, the students produced a 'scenario generator', a tool that included a set of creative props represent- ing social media platforms, users and behaviours. This tool would be used during the briefing session with Northumbria Police to help them generate cybercrime scenarios for further exploration. It is important that resources

created for use in such workshops are both carefully designed, well executed and confidently deployed. In this respect they represent a manifestation of the dual role of designers as design executioners and multidisciplinary facilita- tors. Equally, they have to provide a degree of flexibility to adapt to changing circumstances in real-time.

5.1.4. D: Brief++

The team and the students hosted a two-hour session attended by Northumbria Police representatives, student participants and X academics. During the first 30 minutes, the police outlined key cybersecurity issues and behaviours. This was followed by a creative workshop run by students using their 'scenario generator'. Attendees were divided into two teams with each including a police representative. The physical space had been prepared with long paper sheets, sticky notes, multicoloured pens and the 'scenario genera- tor' props (Figure 6). The session was semi-structured in that there were some guided activities. Two short videos created by students introduced grooming and fraud. Key to this session was that the students had the creative confi- dence to expose incomplete knowledge and ideas to police experts and academics in a highly engaging and playful manner. This helped the students to understand, early on, that their assumptions about the problem space were incomplete, simultaneously eliciting new knowledge from the experts. This is important, as revealing incomplete and fragile ideas is critically important to uncovering new knowledge and stimulating truly new ideas, but it is also chal- lenging, requiring high levels of creative confidence on behalf of the 'revealer'. Well-crafted tools and techniques that support that revelation add scaffolding that support the individual in this practice.

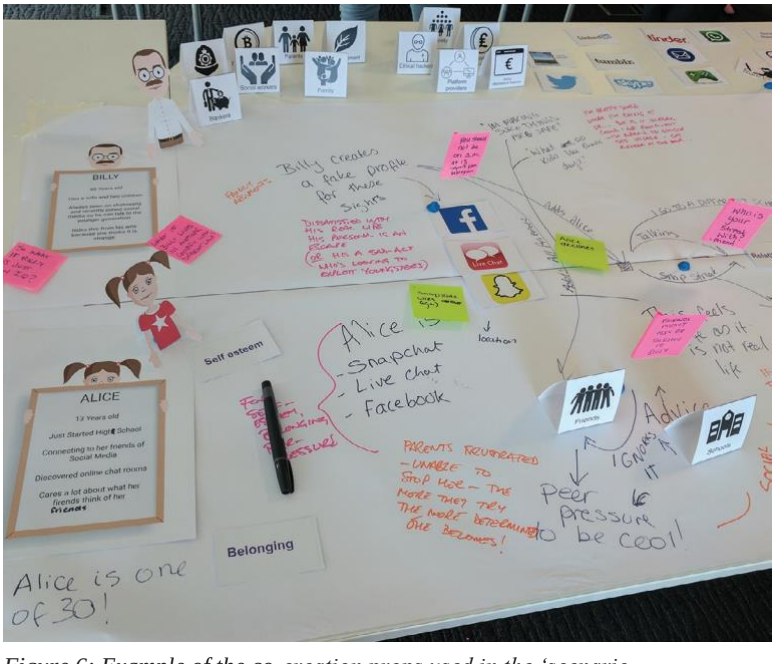


Figure 6: Example of the co-creation props used in the 'scenario generator' tool during the Brief++ activity.

5.1.5. E: Bring in the experts

The students conducted 24 one-to-one interviews and sent questionnaires to experts from industry, government and academia during their twelve-week project. Analysis revealed significant insights into the behaviours and motiva- tions associated with victims and criminals. Moreover, the students identified existing cybersecurity initiatives. Key points from each interview were dynami- cally mapped (Figure 7) and used to update earlier versions of the map created during activity 'C'. More critically, through data analysis, students identified groups that were at high risk of becoming cybercrime victims (teenagers and older people) and key players in cyber-education (teachers and parents). Additionally, it was noted that different types of cybercrime effect different demographics. The complexity and diversity of cybercrimes means they cannot be tackled by just one solution. Sufficiency of relevant education practices was questionable and advice around actions to cybercrime prevention was unclear. The conflicting nature of the attitudes and behaviours collected from experts with different backgrounds were themed and labelled as 'creative tensions' (Sterling et al. 2018).

5.1.6. F: Co-creating with 300 teens

The students created an opportunity to lead a workshop with young people, one of the identified high-risk citizen groups. They designed and developed six activities aimed at gaining a deeper understanding of the young people's experiences of interacting with digital devices. These activities encouraged participants to adopt different roles including advising others on cybersecurity

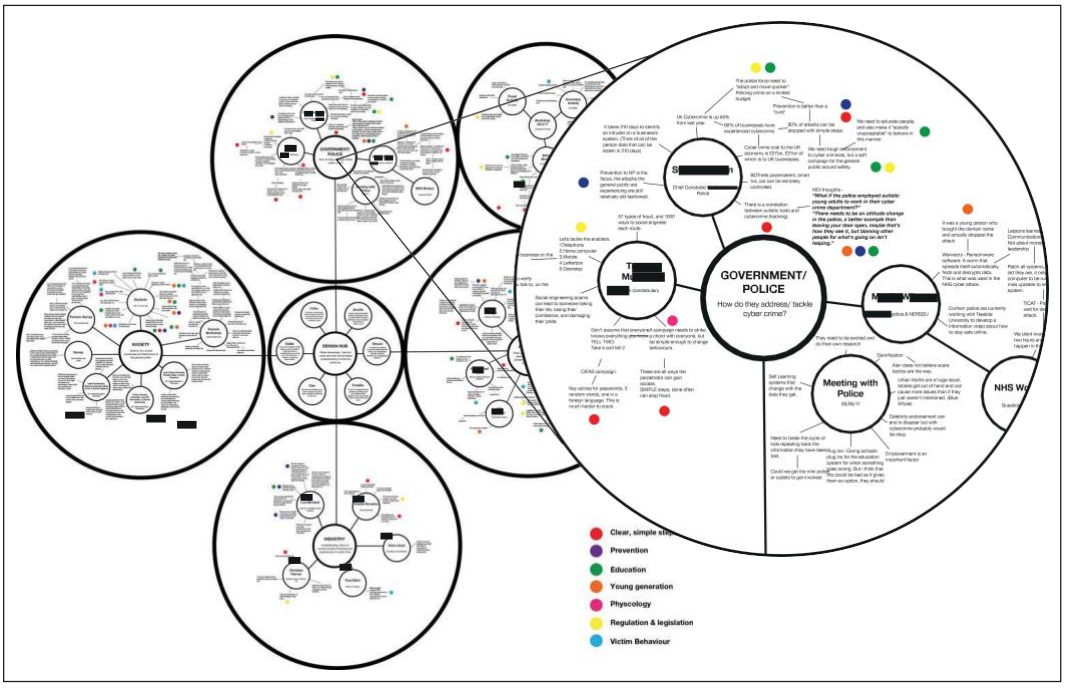


Figure 7: Example of the dynamic stakeholder map created by students to visualize the evolving network of experts engaged during the project.

('advice worksheets'), forming positions as if they were an adult ('act the adult' activity), evaluating current educational practices ('education debate'), reflect- ing on their use of social media ('social media' activity), exploring what is ethical and legal ('ethical vs legal' activity) and drawing scenarios to describe perceived cybercrimes ('comic strip' activity) (Figure 8).

The students engaged with around 300 teenagers during the day and generated significant insights into the attitudes and behaviours of young people, and the challenges surrounding cyber-education. Findings regard- ing teenager's use of social media and digital platforms included: their 'over- dependence' on them as a result of peer-pressure and fear of missing out; the ways that friendship fallouts or bullying can be amplified through them; and criminal or hurtful behaviour not being perceived as 'real' when enacted over the Internet. Significantly, the findings pointed to a shared consensus amongst teenagers and the various experts previously interviewed that cyber- crime education in schools is not sufficient. This is focused, predominantly,

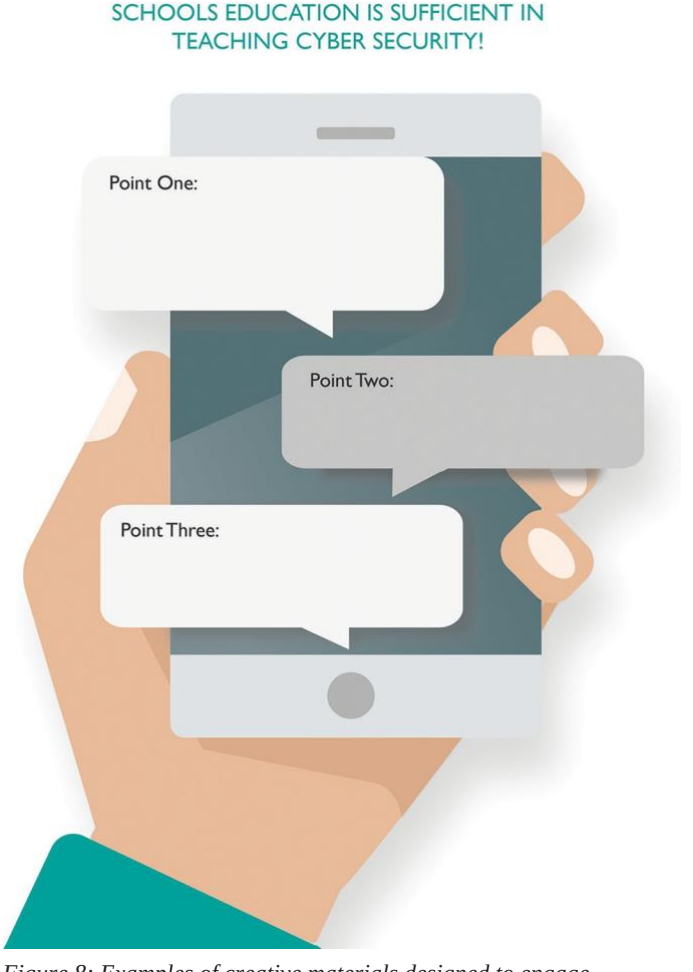


Figure 8: Examples of creative materials designed to engage teenagers in several co-creation activities around behaviours and attitudes in cybercrime.

on ‘traditional’ grooming, ‘stranger-danger’ and sharing of indecent images, and very little about much else, such as cyber-bullying, grooming through online games, password protection, privacy settings and ID theft.

5.1.7. G: Check in and check out

The students met with the team at the midpoint of their twelve-week project to reflect on their findings and create a future direction. This was the most significant point of convergence within the student-led project. Findings about young people seemed to stand out as both the most prolific and raised the most powerful challenges. The team chose to focus on young people as a demographic where raising awareness and changing behaviours could have the greatest long-term impact. Northumbria Police recognized that this was a sensible strategy that represented potential to realize greatest net benefit. The team and the students also decided to consider early stage ideas and opportu- nities to address the challenges associated with that age group. This meeting acted as a catalyst for the remainder of the project as it brought clarity and an impactful direction.

5.1.8. H: Bring in the parents

Having decided to focus on teenagers, the students sought to gain further insights from the perspective of parents. They organized a workshop to investigate how parents educate their children around cyber-safety. Although low attendance at the workshop affected the breadth of perspec- tives, it resulted in detailed questioning and data acquisition. Findings suggested that parents differ regarding the level of online independence and safeguarding advice they give their children. In order to gain a wider perspective, students used insights from the workshop to compile an online questionnaire that was then sent out to parents and guardians. Analysis of the twenty responses revealed parents found it difficult to discuss cyber- crime with their children and there was an expectation that children’s cyber education should be a shared responsibility between parents, schools, government and industry. Findings from the parent-focused research activi- ties and the school workshop were dynamically mapped and themed to reveal new ‘creative tensions’.

5.1.9. I: Visions of a public cyber-wellbeing campaign

The rich insights gathered from the school and parent workshops really inspired the team. An early idea that developed from this inspiration was about targeting different demographics through creative events in venues across the region in order to interact directly with the public and provide cyber education in a fun way. An opportunity was established to engage with a regional museum to explore how they could become a pioneer in teaching this dynamic topic to children. The students ran a co-creation workshop with key museum staff which initially sought to create a ‘shared understanding’ of both the project’s context and the museum’s purpose. It was found that, whilst the museum has an excellent permanent collection and has run many family- oriented programmes, there remained clear opportunity to engage with digi- tal innovation. The students then introduced five themes that their research suggested an educational plan ought to cover: passwords; privacy settings;

virtual versus reality; protect devices; and online threats. Ideation around these themes focused on the possibilities that a new educational programme could provide. A number of fun and engaging activities were identified focusing on helping young people learn through play. After the workshop, the students further developed the ideas and created a set of twenty activity recommenda- tions that the museum could implement as school sessions, family events or permanent fixtures around the venue.

5.1.10. J and K: Towards an open innovation event: Developing and trialling creative stimulus material and provocations

The purpose of the preparatory design activities previously mentioned was to help the team form positions (briefs) and stimulus material in order to co-create early stage proposals and solution opportunities with CDIT busi- nesses. An open innovation event entitled 'Solution Hack' was planned, for which the students needed to translate the breadth of knowledge gener- ated through the preparatory work into provocations again using 'creative tensions'. To test the running of this event and explore how the creative stim- uli would fuel it, a process of trialling and refining took place at two pilot events (Figure 9).

Firstly, the team co-facilitated a twelve-hour workshop (Trial 1), which involved disciplinarily diverse academics, businesses and experts, in intense ideation and development of physical prototypes/solutions using a partner organization's 'FabLab' space which included 3D printers and other machin- ery. The students devised four provocative briefs around digital behaviours and also acted as creative facilitators during the event. Members of the team and the students facilitated the workshop and produced a series of actions to work through along with several design-led tools. These resulted in each of the four groups creating 'provotypes' (Boer and Donovan 2012); provocative concepts and prototypes.

The procedural and thematic knowledge gained from the 'Trial 1' event informed the design of a second pilot co-creation event, called here, 'Trial 2'. This day-long event was essentially the culmination of the student's work over the past two months and its fundamental purpose was to apply their find- ings and pilot their ideas and tools for the Solution Hack event. It was also a chance to create and develop some initial solution opportunities relating to the problem. Seventeen participants drawn from the network of experts the students established in earlier phases of the project, attended the day which

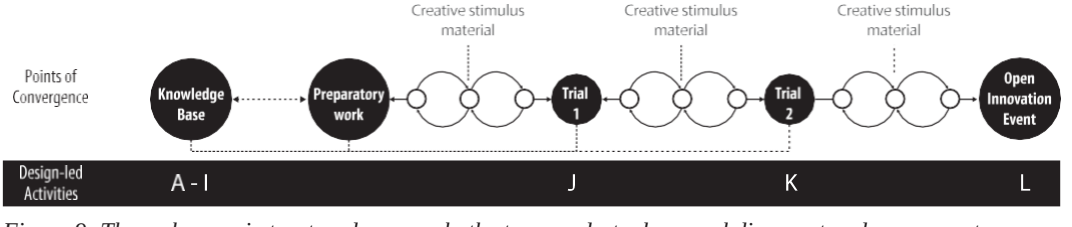


Figure 9: Through a semi-structured approach, the team undertook several divergent and convergent activities, translating new knowledge and insights into new creative stimulus material used and trialled at different co-creation events. Procedural and thematic knowledge gained at each event informed the next iterations.

resulted in eighteen idea cards, synthesized to eleven for further development from which six were further refined and three taken to the final presenta- tion stage. A number of observations in relation to the participants' behav- iours during the event (e.g. a tendency of choosing the easiest to make ideas when it comes to development and pitching) and in the day's structure (e.g. the impact long breaks had on momentum and the importance of making clear when different sessions start and finish) were recorded and many of the initial recommendations in the design of the forthcoming Solution Hack event were altered as a result.

5.1.11. L: Solution Hack

In a creative planning event the team finalized the design of the Solution Hack's agenda and created the six briefs, aligning and enhancing the creative tensions. They introduced the notion of Attitude–Behaviour–Vulnerability as central to the event's choreography.

The purpose of the Solution Hack event was to engage CDIT SMEs and Northumbria Police to generate actionable solutions proposals to address some of the challenges posed by poor cybersecurity amongst teenagers. To achieve this, the team used expertise in inclusive design-led innovation approaches to encourage the sharing of knowledge, skills, experience, expertise and opinions and combine these to create new ideas or build on existing ones.

The twelve-hour open innovation event brought together 30 participants from business, Northumbria Police, student participants and members of the public. It used the creative tensions previously designed to highlight conflict- ing perspectives about particular teen attitudes, behaviours and cyber-vulner- ability. These, and a package of supporting materials (Figure 10), formed the brief: *Achieving teen cyber-wellbeing; How can we raise awareness and influence behaviour-change to address cybercrime vulnerability*? This approach, along with the use of bespoke resources, is critically important in providing participants with key insights drawn from extensive research as the distillation of what is important for the creative session that follows.

In the morning, five teams from mixed backgrounds worked together to generate 80 ideas in response to their briefs. For the afternoon session attend- ees formed two teams; each individual from each team selected those ideas that they felt had potential for development. Prompted by sets of challenges (Figure 11) that aimed to guide the development of ideas, and informed by feedback from police representatives, each team constructed and pitched a solution proposal. One of the proposals presented a concept for an integrated cyber-education programme that saw students acting as cyber-ambassadors, seeking to promote 'authentic' peer learning delivered by students, rather than the teachers. The second proposal was a framework for exploring digital ethics, through actions and consequences. The framework, aligned to primary school age groups, built a portfolio of exciting and engaging activities allow- ing young people, their peers, teachers, family and carers to blend digital and physical interactions, communications and encounters to try to understand the very real ethical and potentially dangerous consequences of certain digital behaviours.

The event created value to both attendees and police representatives; the former gained from being exposed to a pressing social challenge; experienc- ing a novel approach to problem solving; and by working with a range of

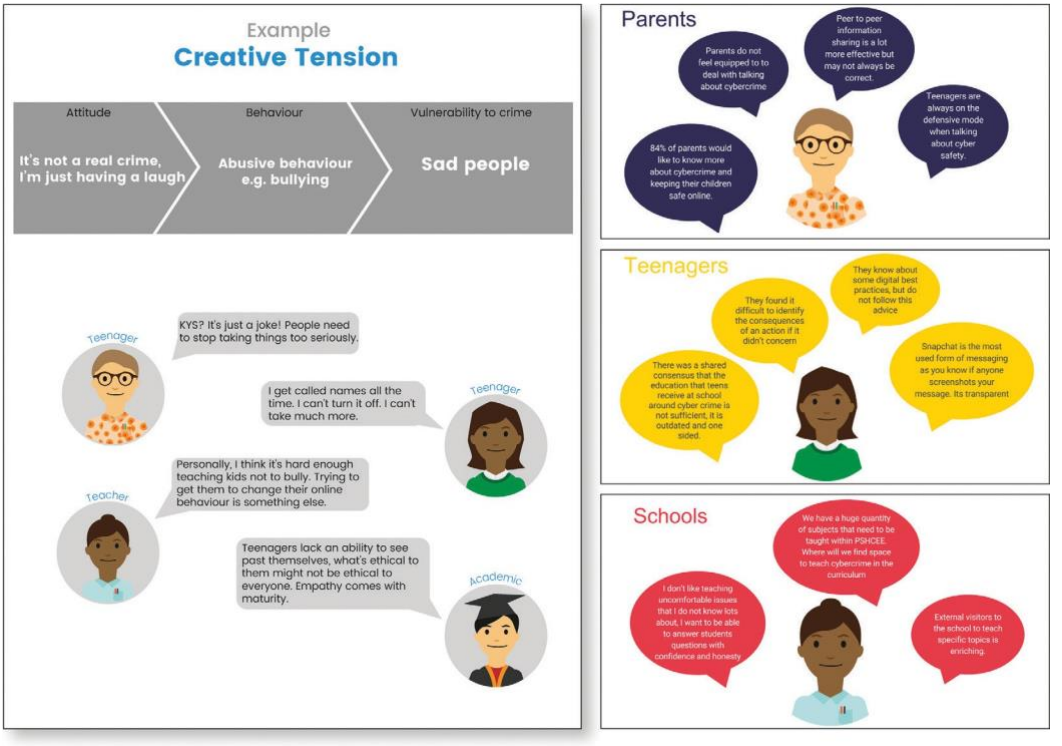


Figure 10: Examples of stimulus materials drawn from the team's research findings, provided to teams to describe the context and drive creative thinking amongst participants.

new people from different professional and social backgrounds with different levels of experience and expertise. Northumbria Police reported that the event allowed them to work with a University in a new way, through an approach that generated ideas for future initiatives and actions:

> Working creatively, with a range of experts, to generate solutions was tremendously exciting. If we can execute and deliver some of these ideas, they will catch on like wildfire, there is such potential to make a difference.
> (Senior Northumbria Police member)

5.1.12. M: Strategic position

During activity M, the team carried out a number of creative sessions and revisited research and design outputs produced throughout the twelve project phases. The aim was to analyse and synthesize the rich collateral into a set of key value propositions and formulate a 'strategic report' to share with Northumbria Police and continue to work with them to seek funding to see proposals emerging from the event through to pilot implementation.

The strategic report outlined key findings and recommendations on how Northumbria Police could take a leadership position in cybercrime

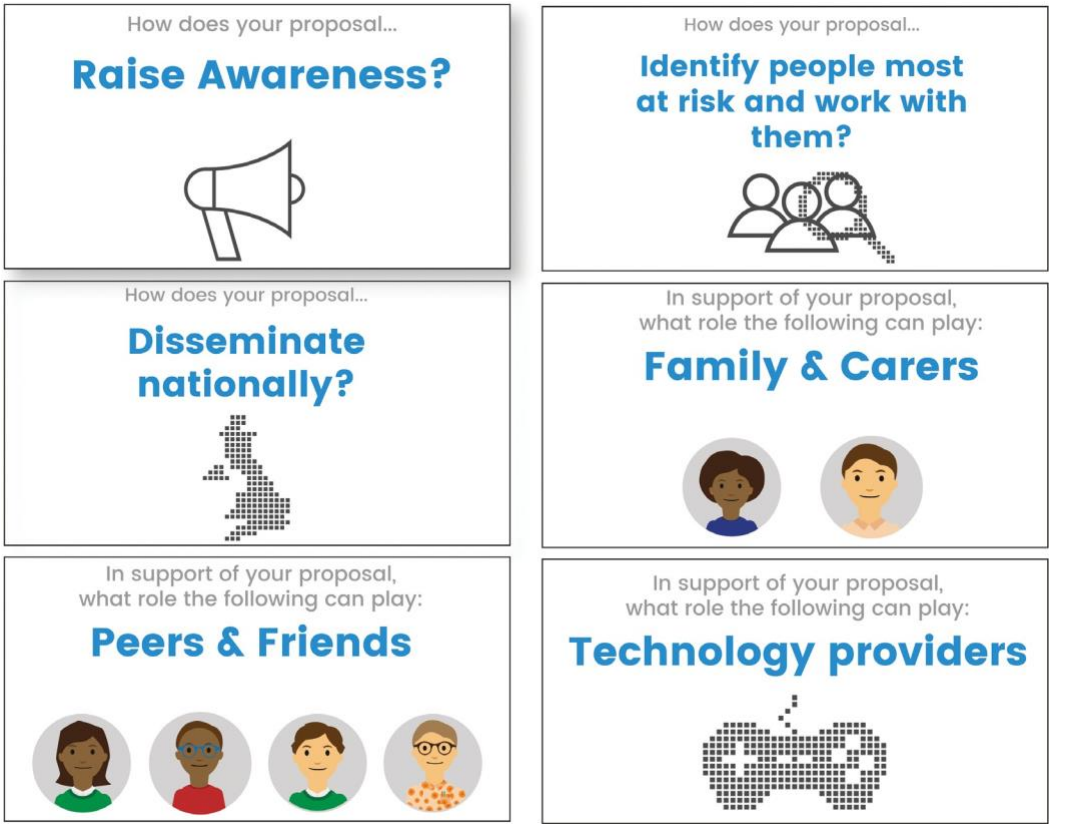


Figure 11: Design challenge cards presented to each team during ideas development to inspire a multidimensional approach.

prevention both regionally and nationally. For example, one of the key project findings was that 'cyber-education' resources need to be more rele- vant, detailed and draw on real cases in order to engage young people. The team suggested that by adopting an original, creative approach, Northumbria Police could create resources which are both informative and truly engage young people in discussion and debate around the diffi- cult decisions they have to make during Internet use. The report further proposed a strategic approach to achieve this; by connecting with local creative and digital businesses to: (1) create rich, youth-focused compel- ling case studies, (2) generate assets to communicate these narratives effec- tively from multiple perspectives (perpetrator, victim, peers, parent, witness, investigating officer, etc.), (3) create platforms which support young people to engage in discussion, debate and community action and help adults to facilitate this engagement and (4) offer the police tools for staff develop- ment (Figure 12).

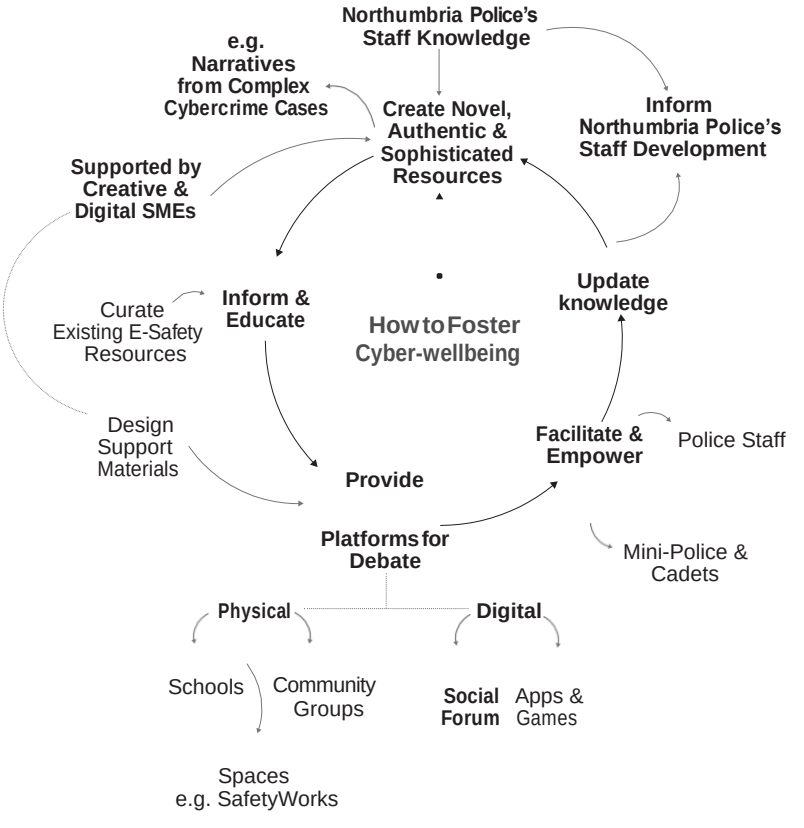


Figure 12: Northumbria University's strategic proposal for a programme of initiatives to enable Northumbria Police to take a leadership position in cybercrime prevention.

6. Design-led enablers throughout project activities

Over the thirteen project activities, the team arrived at three key convergent points, (1) framing problem spaces and themes (activities A–H), (2) early stage actionable solution opportunities that were used both for stimulating creative thinking and as strategies for developing solutions (activities I–L), (3) devel- opment of a strategy to foster cyber-wellbeing (M).

Figure 13 depicts the range of enablers employed throughout the different phases of the projects and their points of convergence.

While it can be seen as though almost all enablers were present across the majority of the project activities, upon closer investigation, the intensity with which the enablers influenced each phase outcomes (hence, the project itself) varied.

For example, in activity D ('Brief++'), the 'participation'enabler was deficient; only a few police representatives attended the session due to a security incident demanding their attention. This had an impact on the 'structure' enabler as the planned creative activities were devised with more expert participants in mind. Moreover, this deficiency affected the project by slowing down one important early stage objective: establishing and engaging expertise in the process.

During activity E ('Bring in the experts') the students engaged with experts across industry, society, government and academia, all of whom contributed knowledge. However, only some converted into activists (in that they actively participated in co-creation activity), thereby missing the opportunity of deeper

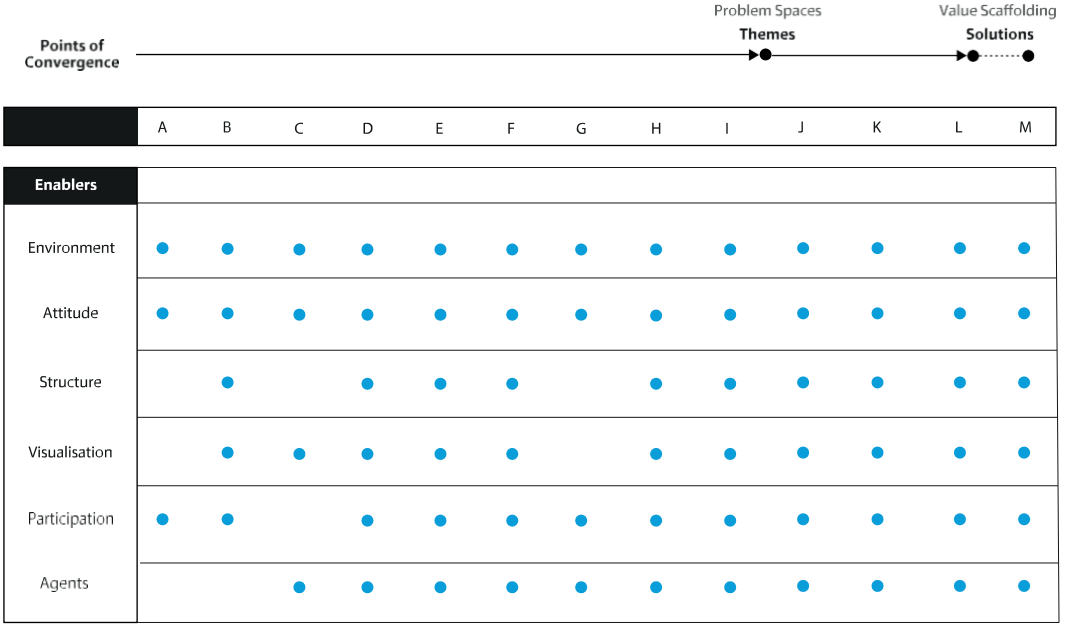


Figure 13: The different design-led enablers employed during the thirteen project phases based on the conceptual framework introduced earlier in the paper.

engagement in subsequent events. Enablers such as being open to a chang- ing 'structure'meant that students were able to identify that collecting teacher's perspectives would be beneficial and adapt their plans to include one-to- one interviews with teachers. In the same way, the flexibility of the 'struc- ture' enabler allowed students to compensate for the deficit of parents during Activity H ('Bring in the parents') by (1) by collecting more in-depth data and
(2) devising other means to enable more diverse data collection.

In activity J 'Trial 1' the team had little to no control over the environ- ment and participants as the partner institution managed these. However, as the event took place at a 'FabLab', this helped foster a mindset of 'making' and 'experimentation'. To compensate for a lack of control, enablers such as 'structure' ranging from the creation of briefs prior to the event, to the role the team and students had in facilitating the day were important, while the 'visualization' and 'attitude' enablers provided a set of fun and engaging activities. While 'participation' was high in that all teams actively engaged and co-created according to their challenges, the enabler can be seen as defi- cient as only one team explored challenges relating to cyber-wellbeing which resulted in only one relevant concept coming out from that activity.

Deficits were also observed in enablers 'structure', 'visualization' and 'participation' during activity K 'Trial 2'. For example, momentum was negatively impacted due to the lack of a well-planned 'structure' in the day and the unclear start/finish points during different activities. This highlights the importance of balancing structure and flexibility. Moreover, participants were not obliged to stay for the whole day which caused disruption to the composition of teams and no proactive mechanisms were in place to anticipate this. On the other hand, the 'visualization' enabler consisted of such a wealth of tools and creative stimuli that it was questionable whether they fostered a

better engagement or overwhelmed and disrupted participants' creative think- ing. The lack of police expertise and lower engagement from academics of partner institutions (partly because of not turning enough 'experts' into 'activ- ists') had a detrimental effect on the day's outcomes.

During activity L ('Solution Hack') the team identified two enabler defi- cits, 'visualization' and 'participation'. In the former enabler, it was observed that some participants treated creative materials (provocations and tensions) as 'descriptions of cybercrime' rather than 'context for action', thereby dismiss- ing them in order to pursue solutions based on their personal experience (rather than the supplied research). In terms of the 'participation' enabler, this event fell short of achieving engagement with the CDIT businesses. However, in contrast to activity K discussed earlier, the flexible 'structure' had antici- pated the disruption caused when participants stayed only for part of the day and successfully enabled a non-disrupted event.

Finally, during activity M, all enablers were evident during the team's review of creative outputs but 'environment', 'attitude' and 'participation' were particularly useful. For instance, the team was able to utilize a dedicated project space to gather and visualize relevant project outputs and stimulate the team's creative thinking. Prior to the formulation of the final strategic report, the team hosted Northumbria Police representatives in this space in order to showcase research and creative outputs and to discuss their strategic position and recommendations that formed the basis of the final report.

Figure 14 depicts the varying influence of the enablers during the different project phases.

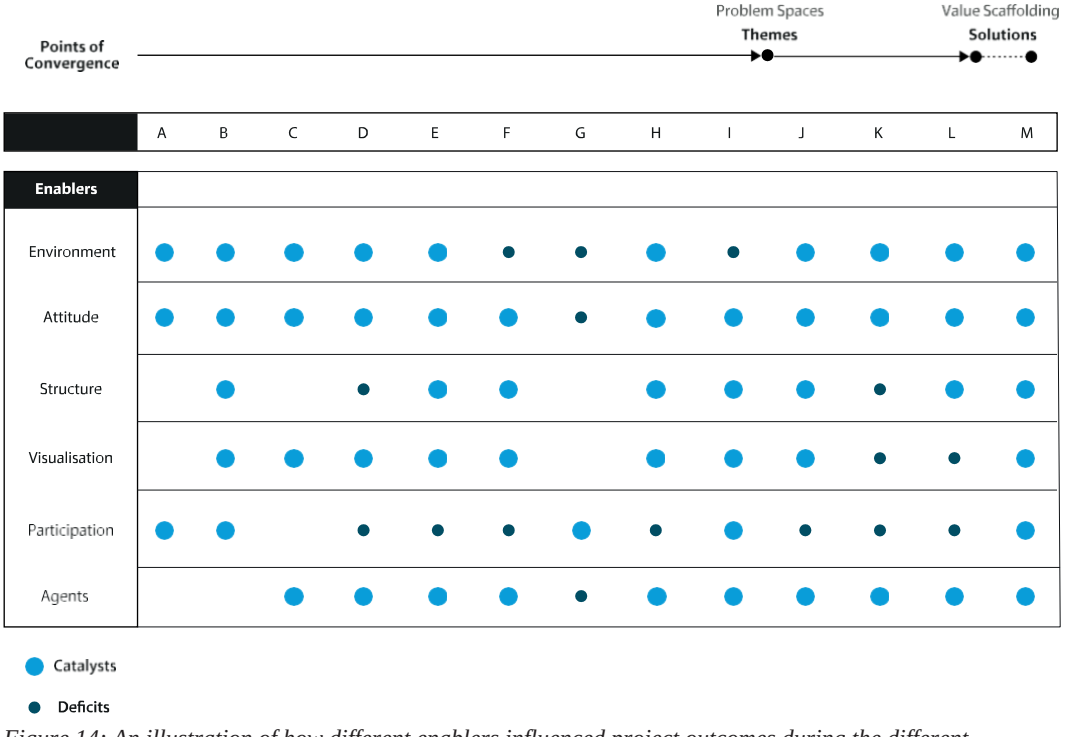


Figure 14: An illustration of how different enablers influenced project outcomes during the different activities. Larger diameter circles indicate greater density and importance, while the smaller indicate a deficit.

7. Lessons learned

7.1. On design frames

Past research has argued that in dynamic wicked problems, there is a need to be able to question critically and break down what is truly important to which stakeholders. Indeed, adopting an approach that seeks to tease out actionable design-briefs as part of a larger, semi-structured programme allows organiza- tions to consider where to focus energy and resource. The case study described in this article found that by acknowledging the co-evolution of problem and solution-spaces as part of *trust-building* at the start of a programme of work, it is possible to enter into that work uncertain about the specific methods, tools or destination, but aware that, if required, there will be stepping-off points at the project's points of convergence. Moreover, the case study identified an area of equal importance (yet generally neglected in current design-led stud- ies), that is, the language used to describe and draw actors together around a 'wicked problem'. By adopting new, positive language, shifting from 'problem' and 'solution' to 'situation' and 'opportunity', we can shift to a more opti- mistic and creatively confident mindset amongst 'situation' owners.

The case study discussed in this article described NU's design-led approach to tackling a dynamic wicked situation: cybercrime. Through this approach, academics, researchers and postgraduate students engaged stake- holders creatively to explore young people's cyber-vulnerability and define the tools needed to help raise awareness and influence positive behaviour-change. As understanding of the situation and opportunities co-evolved throughout this collaboration, it revealed a different reality from that which Northumbria Police had originally thought was needed to help 'solve the problem'. To reach solution opportunities, NU's approach (re)framed and transformed the wicked problem into a *design situation* by collecting knowledge, asking pertinent questions, and generating speculative ideas. Such problem transformation can be found in the way the situation was eventually framed: from 'cybercrime' to 'cyber-wellbeing' and from 'prevention' to 'raising awareness and influ- encing behaviour-change to address cybercrime vulnerability'. Furthermore, Northumbria Police had originally approached CFNE with a *problem to solve*
i.e. how to prevent cybercrime. At the time, it was thought that the solution could be simply developing a number of 'cool' digital applications to engage the public with 'what to do/not to do' information and guidance. Through a design-led approach, the problem was reframed as a *situation* which led to deeper understanding of what was actually needed, while revealing new *opportunities* in the specific situation developed; a more holistic, contempo- rary and relevant 'cyber-education' programme whose impact could reach two worlds simultaneously: new public engagement strategies and better curation of resources would also result in contemporaneous knowledge readily avail- able to support internal staff development.

Activities such as: engaging with diverse expertise across industry, academia, society and government; identifying and engaging with high-risk citizen groups; trialling creative materials in pilot co-creation events; and a series of creative planning events, were amongst the most valuable in situa- tion-framing. This framing was achieved through a process that needed care- ful facilitation to bring people together around a common purpose and foster their creativity.

7.2. On co-creation enablers

This study proposes six enablers (environment, attitude, structure, visuali- zation, participation and agents) that were deployed to bring stakeholders together to move from a position of ambiguity to one where there are strategic and actionable solution opportunities. The evidence presented in this article suggests that amongst the six enablers, the 'participation' enabler is the hardest one to activate. It is particularly challenging when stakeholders are not famil- iar with design-led approaches, not supported by their organizational culture or there are no immediate (monetary) rewards in the case of commercial busi- nesses. NU's design-led strategy to tackle 'participation' deficits in the case study in question was through another enabler, 'structure'; having a highly adaptable structure enabled the team to anticipate and reform in response to changing circumstances throughout the project, especially during stakeholder engagement events. However, this strategy fell short in regard to the team's lack of success in attracting engagement from commercial businesses such as the digital SMEs – even adapting the project structure to suit the needs of these businesses failed to achieve significant engagement as the businesses were unable to see an immediate return on time invested. This is a significant and critical lesson for anyone seeking to develop this sort of relationship.

Previous research has noted the important role of visualization in creating common language, understanding and purpose amongst participants. However, the 'visualization' enabler can encompass such a wealth of tools and creative stimuli that this can become overwhelming and disruptive to partici- pation. In this study it was questionable, on occasion, whether visualization tools fostered a better engagement or disrupted participants' creative thinking. Novice facilitators, such as the students involved in this case study, demonstrated a tendency to over-resource workshops; apprehensive about achiev- ing enough creative engagement from participants, they would overload them with visual prompts, templates and tools, thereby generating too much 'noise' to leave space for creativity.

Finally, it was observed that the 'agents' enabler, represented in this project by a group of multidisciplinary students, through their own contex- tual naivety, gave participants permission to behave creatively and ask appar- ently naive 'what if' and 'why' questions which are critical to creative practice. This had an amplifying effect upon every other enabler, making them a crucial ingredient in NU's design-led approach to business-engaged co-creative research and innovation. The consequence of this, combined with the adop- tion of the optimistic situation/opportunity language, contributed to a percep- tible increase in evident creative confidence amongst those who did convert from 'expert' to 'activist'.

8. Concluding remarks

It is clear from this case study that the co-creation enablers employed do support stakeholders in developing the creative confidence required to tran- sition from 'expert participant' to co-creation activist, and the authors have concentrated their evaluation on the lessons that can be learned when the enablers are not as effective as hoped. Similarly, the case study demonstrates how design-led approaches can translate a wicked problem into action- able innovation briefs. For practitioners wishing to adopt such approaches, the study highlights the critical importance of employing an adaptable, fluid

approach when addressing wicked problems. This requires a high degree of confidence and experience on the part of the facilitators and trust from all stakeholders. Furthermore, striking the right balance with the number and nature of supporting resources used in facilitation is important and poses the further question 'when do enablers become disablers and how can practition- ers guard against this?'. Within academia, we have the opportunity, particu- larly where an integrated academic practice model (Bailey and Smith 2016) is employed, to prototype, test and refine such tools within the context of integrated research and education projects conducted with external partner organizations. In this way, academics are able to support the development of knowledge and practice in co-creative practice.

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REFERENCES

Alves, J., Marques, M. J., Saur, I. and Marques, P. (2007), 'Creativity and inno- vation through multidisciplinary and multisectoral cooperation', *Creativity and Innovation Management*, 16:1, pp. 27–34.

Bailey, M., Aftab, M. and Duncan, T. (2014), 'New design is bigger and harder – Design mastery in a changing world', in E. Bohemia, A. Eger, W. Eggink, A. Kovacevic, B. Parkinson and W. Wits (eds), *DS 78: Proceedings of the 16th International Conference on Engineering and Product Design Education (E&PDE14)*, Design Education and Human Technology Relations, University of Twente, 4–5 September, Enschede: The Design Society, Institution of Engineering Designers, pp. 443–48.

Bailey, M., Aftab, M. and Smith, N. (2015), 'Hidden value-towards an unders- tanding of the full value and impact of engaging students in user-led research and innovation projects between universities and companies', in *LearnxDesign: Proceedings of the 3rd International Conference for Design Education Researchers*, 28–30 June, Chicago: Aalto University, pp. 290–307.

Bailey, M. and Smith, N. (2010), 'Safe environments for innovation-develo- ping a new multidisciplinary masters programme', in *DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education, When Design Education and Design Research meet…*, Trondheim, 2–3 September, Glasgow: The Design Society, pp. 60–65.

——— (2016), 'Making it work; Integrated academic practice', in *Proceedings of 20th DMI: Academic Design Management Conference; Inflection Point: Design Research Meets Design Practice*, Boston, 22–29 July, Boston: Design Management Institute, pp. 2346–63.

Bailey, M., Smith, N. and Aftab, M. (2013), 'Connecting for impact-multidis- ciplinary approaches to innovation in small to medium sized enterprises (SMEs)', *DRS // Cumulus Conference 2013, The 2nd International Conference*

for Design Education Researchers, Oslo, The Design Research Society, 14–17 May.
Bandura, A. (1982), 'Self-efficacy mechanism in human agency', *American Psychologist*, 37:2, pp. 122–47.
Beckman, S. and Barry, M. (2008), 'Developing design thinking capabilities', *Step Inside Design*, 24, pp. 82–87.
Björgvinsson, E., Ehn, P. and Hillgren, P.-A. (2010), 'Participatory design and democratizing innovation', in *PDC '10, Proceedings of the 11th Biennial Participatory Design Conference*, Sydney, 29 November–3 December, New York: ACM, pp. 41–50.
——— (2012a), 'Agonistic participatory design: Working with marginalised social movements', *CoDesign*, 8:2&3, pp. 127–44.
——— (2012b), 'Design things and design thinking: Contemporary participa- tory design challenges', *Design Issues*, 28:3, pp. 101–16.
Bødker, S. (1996), 'Creating conditions for participation: Conflicts and resour- ces in systems development', *Human-Computer Interaction*, 11:3, pp. 215–36.
Boer, L. and Donovan, J. (2012), 'Provotypes for participatory innovation', in *DIS 12, Proceedings of the Designing Interactive Systems Conference*, Newcastle Upon Tyne, 11–15 June, New York: ACM, pp. 388–97.
Bornet, C. and Brangier, E. (2016), 'The effects of personas on creative code- sign of work equipment: An exploratory study in a real setting', *CoDesign*, 12:4, pp. 243–56.
Bowen, S., Durrant, A., Nissen, B., Bowers, J. and Wright, P. (2016), 'The value of designers' creative practice within complex collaborations', *Design Studies*, 46, pp. 174–98.
Broadley, C., Champion, K., Johnson, M. P. and McHattie, L.-S. (2016), 'From participation to collaboration: Reflections on the co-creation of innovative business ideas', in P. Lloyd and E. Bohemia (eds), *Proceedings of DRS2016: Design + Research + Society - Future-Focused Thinking*, vol. 5, Brighton, 27–30 June, Brighton: The Design Research Society, pp. 1739–58.
Brown, T. and Katz, B. (2009), *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, New York: Harper Collins.
Brown, T. and Wyatt, J. (2010), 'Design thinking for social innovation', *Development Outreach*, 12:1, pp. 29–43.
Brown, V. A. (2010), 'Collective inquiry and its wicked problems', in V. A. Brown, J. A. Harris and J. Y. Russell (eds), *Tackling Wicked Problems through the Transdisciplinary Imagination*, London: Earthscan, pp. 61–83.
Buchanan, R. (1992), 'Wicked problems in design thinking', *Design Issues*, 8:2, pp. 5–21.
Bucolo, S. and Matthews, J. H. (2011), 'Design led innovation: Exploring the synthesis of needs, technologies and business models', *Participatory Innovation Conference 2011*, University of Southern Denmark, Sønderborg, 13–15 January.
Bucolo, S. and Wrigley, C. (2014), 'Design-led innovation: Overcoming challenges to designing competitiveness to succeed in high cost environ- ments', in G. Roos and N. Kennedy (eds), *Global Perspectives on Achieving Success in High and Low Cost Operating Environments*, Hershey, PA: IGI Global, pp. 241–51.
Bucolo, S., Wrigley, C. and Matthews, J. (2012), 'Gaps in organizational leader- ship: Linking strategic and operational activities through design-led propositions', *Design Management Journal*, 7:1, pp. 18–28.

Coyne, R. (2005), 'Wicked problems revisited', *Design Studies*, 26:1, pp. 5–17.
Cross, N. (2006), *Designerly Ways of Knowing*, London: Springer.
Davis, J., Docherty, C. A. and Dowling, K. (2016), 'Design thinking and innova- tion: Synthesising concepts of knowledge co-creation in spaces of profes- sional development', *The Design Journal*, 19:1, pp. 117–39.
Department for Business, Energy & Industrial Strategy (2017), *Building Our Industrial Strategy: Green Paper*, London: HM Government, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/611705/building-our-industrial-strategy-green-paper.pdf. Accessed 14 March 2017.
Design Council (2015), *The Design Economy: The Value of Design to the UK*, London: Design Council, https://www.designcouncil.org.uk/sites/default/files/asset/document/The%20Design%20Economy%20executive%20summary.pdf. Accessed 25 July 2018.
Dombrowski, C., Kim, J. Y., Desouza, K. C., Braganza, A., Papagari, S., Baloh, P. and Jha, S. (2007), 'Elements of innovative cultures', *Knowledge and Process Management*, 14:3, pp. 190–202.
Dorst, K. (2011), 'The core of "design thinking" and its application', *Design Studies*, 32:6, pp. 521–32.
——— (2015), *Frame Innovation: Create New Thinking by Design*, Cambridge, MA: MIT Press.
Dorst, K. and Cross, N. (2001), 'Creativity in the design process: Co-evolution of problem solution', *Design Studies*, 22:5, pp. 425–37.
Facer, K. and Enright, B. (2016), *Creating Living Knowledge: The Connected Communities Programme, Community-University Relationships and the Participatory Turn in the Production of Knowledge*, Bristol: University of Bristol.
Flyvbjerg, B. (2011), 'Case study', in N. K. Denzin and Y. S. Lincoln (eds), *The Sage Handbook of Qualitative Research*, 4th ed., Thousand Oaks: Sage, pp. 301–16.
Fong, S. W. P. (2003), 'Knowledge creation in multidisciplinary project teams: An empirical study of the processes and their dynamic interrelationships', *International Journal of Project Management*, 21:7, pp. 479–86.
Fraser, H. (2012), *Design Works: How to Tackle Your Toughest Innovation Challenges through Business Design*, Toronto: University of Toronto Press.
Fremantle, C., Gulari, M. N., Fairburn, S. M., Hepburn, L.-A., Valentine, G. and Meagher, L. (2016), 'Impact by design: Evaluating knowledge exchange as a lens for evaluating the wider impacts of a design-led business support programme', in *Proceedings of the 20th Academic Design Management Conference (DMI: ADMC), Inflection Point: Design Research Meets Design Practice*, Boston, 28–29 July, Boston: Design Management Institute, pp. 410–34.
Gerring, J. (2007), *Case Study Research: Principles and Practices*, New York: Cambridge University Press.
Gray, D., Brown, S. and Macanufo, J. (2010), *Gamestorming: A Playbook for Innovators, Rulebreakers and Changemakers*, Cambridge: O'Reilly.
Gulari, M. N. and Fremantle, C. (2015), 'Are design-led innovation approaches applicable to SMEs?', in G. Bingham, D. Southee, J. Mccardle, A. Kovacevic, E. Bohemia and B. Parkinson (eds), *Great Expectations: Design Teaching, Research and Enterprise; Proceedings of the 17th International Conference on Engineering and Product Design Education (E&PDE15)*, 3–4 September, Glasgow: The Design Society.

Hocking, V. T. (2010), 'Designerly ways of knowing: What does design have to offer', in V. A. Brown, J. A. Harris and J. Y. Russell (eds), *Tackling Wicked Problems: Through the Transdisciplinary Imagination*, London: Earthscan, pp. 242–50.
Innovate UK (2015), *Design in Innovation Strategy 2015–2019*, Swindon: Technology Strategy Board, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/474557/Design_in_Innovation_ Strategy_2015-2019_WEB.pdf. Accessed 18 May 2018.
Jenssen, J. I. and Jörgensen, G. (2004), 'How do corporate champions promote innovations?', *International Journal of Innovation Management*, 8:1, pp. 63–86.
Kelley, D. and Kelley, T. (2013), *Creative Confidence: Unleashing the Creative Potential Within Us All*, New York: Crown Business.
Knowles, H. and Spencer, N. (2016), 'Designing with stakeholders during social innovation projects: A mapping and analysis tool', in E. Bohemia, L. Buck, K. Eriksen, A. Kovacevic, N. Ovesen and C. Tollestrup (eds), *DS 83, Proceedings of the 18th International Conference on Engineering and Product Design Education (E&PDE16), Design Education: Collaboration and Cross-Disciplinarity*, Aalborg, Denmark, 8–9 September, Glasgow: The Design Society.
Krabye, A., Matthews, J., Wrigley, C. and Bucolo, S. (2013), 'From produc- tion to purpose-using design led innovation to build strategic potential in a family-owned SME', *IEEE Tsinghua International Design Management Symposium*, Shenzhen, 1–2 December, New Jersey: Institute of Electrical and Electronics Engineers, pp. 37–46.
Kyffin, S., Aftab, M. and Spencer, N. (2017), 'Social value creation through multidisciplinary design education', *IASDR 2017, Design Research Conference*, Cincinnati, International Association of Societies of Design Research, 31 October–3 November.
Lam, B. (2017), 'Applying strategic design as a holistic approach to investigate and address real world challenges', *Strategic Design Research Journal*, 10:2, pp. 164–71.
Liedtka, J. (2011), 'Learning to use design thinking tools for successful innova- tion', *Strategy & Leadership*, 39:5, pp. 13–19.
Mello Freire, K. de (2017), 'From strategic planning to the designing of stra- tegies: A change in favor of strategic design', *Strategic Design Research Journal*, 10:2, pp. 91–96.
Michlewski, K. (2016), *Design Attitude*, New York: Routledge.
Morehen, J., Wrigley, C. and Wright, N. (2013), 'Teaching design thinking and design led innovation to non-designers: A tertiary facilitator multi- disciplinary study', in *Proceedings 2013 IEEE Tsinghua International Design Management Symposium: Design-Driven Business Innovation*, Shenzhen, 1–2 December, New Jersey: Institute of Electrical and Electronics Engineers, pp. 55–63.
Myerson, J. (2018), 'Keynote address', *E&PDE, 20th International Conference on Engineering & Product Design Education*, London, 6–7 September.
Nissani, M. (1997), 'Ten cheers for interdisciplinarity: The case for interdiscipli- nary knowledge and research', *The Social Science Journal*, 34:2, pp. 201–16. Norman, D. A. and Verganti, R. (2014), 'Incremental and radical innovation: Design research vs. technology and meaning change', *Design Issues*, 30:1, pp. 78–96.

Nusem, E., Matthews, J., Wrigley, C. and Bucolo, S. (2013), 'The challenges of adopting design-led innovative strategies in not for profits: The role of consumers, culture and employees', in *Proceedings 2013 IEEE Tsinghua International Design Management Symposium: Design-Driven Business Innovation*, Shenzhen, 1–2 December, New Jersey: Institute of Electrical and Electronics Engineers, pp. 284–93.

Nusem, E., Wrigley, C. and Matthews, J. (2017), 'Developing design capability in nonprofit organizations', *Design Issues*, 33:1, pp.61–75.

Parkinson, D., Bohemia, E., Yee, J. and Smith, N. (2012), 'Design process and organisational strategy: A storytelling perspective', *Design Research Society 2012: Bangkok*, Bangkok, Chulalongkorn University, 1–4 July, Bangkok.

Price, R., Wrigley, C., Dreiling, A. and Bucolo, S. (2013), 'Design led innovation: Shifting from smart follower to digital strategy leader in the Australian airport sector', in *Proceedings 2013 IEEE Tsinghua International Design Management Symposium: Design-Driven Business Innovation*, Shenzhen, 1–2 December, New Jersey: Institute of Electrical and Electronics Engineers, pp. 251–58.

Rittel, H. W. and Webber, M. M. (1973), 'Dilemmas in a general theory of plan- ning', *Policy Sciences*, 4:2, pp. 155–69.

Robson, C. (2002), *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*, 2nd ed., Oxford: Blackwell Publishers.

Rogers, E. M. (2003), *Diffusion of Innovations*, New York: Free Press.

Russell, J. Y. (2010), 'A philosophical framework for an open and critical trans-disciplinary inquiry', in V. A. Brown, J. A. Harris and J. Y. Russell (eds), *Tackling Wicked Problems through the Transdisciplinary Imagination*, London: Earthscan, pp. 31–60.

Sanders, E. B.-N. and Stappers, P. J. (2008), 'Co-creation and the new landsca- pes of design', *Co-Design*, 4:1, pp. 5–18.

——— (2014), 'Probes, toolkits and prototypes: Three approaches to making in codesigning', *CoDesign*, 10:1, pp. 5–14.

Sanders, E. B.-N. and Westerlund, B. (2011), 'Experiencing, exploring and experimenting in and with co-design spaces', *Nordic Design Research Conference, Making Design Matter*, Helsinki, NORDES, 29–31 May.

Sapsed, J., Nightingale, P., Camerani, R., Mateos-Garcia, J., Voss, G., Coad, A. and Byford, J. (2013), *The Brighton Fuse*, Brighton: University of Brighton and Sussex, http://sro.sussex.ac.uk/63573/1/The Brighton Fuse.pdf. Accessed 10 February 2017.

Schoffelen, J., Claes, S., Huybrechts, L., Martens, S., Chua, A. and Moere, A. V. (2015), 'Visualising things: Perspectives on how to make things public through visualisation', *CoDesign*, 11:3&4, pp.179–92.

Sinek, S. (2011), *Start with Why: How Great Leaders Inspire Everyone to Take Action*, London: Portfolio Penguin.

Spencer, N., Bailey, M., Smith, N., Davidson, J. and Sams, P. (2017), 'What on earth is responsible innovation anyway? (And how to teach it)', in *DS 88: Proceedings of the 19th International Conference on Engineering and Product Design Education (E&PDE17), Building Community: Design Education for a Sustainable Future*, Oslo, 7–8 September, Institution of Engineering Designers, The Design Society, pp. 38–43.

Sterling, N., Bailey, M., Spencer, N., Lampitt Adey, K., Chatzakis, E. and Hornby, J. (2018), 'From conflict to catalyst: Using critical conflict as a creative device in design-led innovation practice', in *The 21st DMI: Academic Design Management Conference Proceedings; ADMC18: Next*

Wave, Ravensbourne University London, 1–2 August, Boston: The Design Management Institute, pp. 226–36.
Vaajakallio, K. and Mattelmäki, T. (2014), 'Design games in codesign: As a tool, a mindset and a structure', *CoDesign*, 10:1, pp. 63–77.
Verganti, R. (2009), *Design-Driven Innovation: Changing the Rules of Competition by Radically Innovating What Things Mean*, Boston, MA: Harvard Business School Press.
Wrigley, C. (2016), 'Design innovation catalysts: Education and impact', *She Ji: The Journal of Design, Economics and Innovation*, 2:2, pp. 148–65.
——— (2017), 'Principles and practices of a design-led approach to innovation', *International Journal of Design Creativity and Innovation*, 5:3&4, pp. 235–55.
Wrigley, C. and Straker, K. (2017), 'Design thinking pedagogy: The educational design ladder', *Innovations in Education and Teaching International*, 54:4, pp. 374–85.
Yin, R. (2014), *Case Study Research: Design and Methods*, Thousand Oaks: Sage.

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Publication 7

The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum

This double-blind, peer reviewed article, published in The International Journal of Design Education, (2019) explores the design, and iterative development of the MDI programme over a period of ten-years. It establishes how the programme has transitioned from being simply a research-informed teaching programme to a research oriented community of integrated academic practice. It reveals the importance of stakeholder priorities as drivers of curricular currency and relevance. As such, it presents the programme as having a fluid curriculum simultaneously determined by the contemporaneous pressing needs of students (as future employees), business (represented by partnering organisations), society and academia. The study reveals the underlying pedagogic principles and aspects of delivery that have ensured that these values are delivered.

Considering the disciplinary upbringing of individual students, the study highlights the importance of establishing reflexivity and encouraging students to continually question what they are doing and why they are doing it.

The particular significance of this work to this submission is with regard to the evidence it provides relating to the validity of maintaining curricular fluidity and adaptability underpinned by fundamental pedagogic approaches supported by critical reflection.

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The Why and How of Design-led Multidisciplinary Innovation Education

Context and Curriculum

MARK BAILEY AND NICHOLAS SPENCER

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The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum

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Abstract: This study charts the design and development of a pioneering design-led multidisciplinary innovation Master's degree; a degree in Design Thinking. It reviews a decade of delivery of the programme and considers the contextual factors that influenced its original design and subsequent iterations. The study uses a critical participatory action research methodology and draws on previous research conducted on and through the programme in question, together with stakeholder surveys and interviews. The programme in question has evolved from its original manifestation as a teaching programme to an entity that acts as a locus for education, research, and practice in design-led innovation. As such, the study identifies four essential stakeholders—students, partner organisations, society, and academia—whose priorities have formed the contextual elements that have driven the programme's introduction and development. It considers their influence on the programme design and the values derived by each from the programme. Furthermore, the study reveals the underlying pedagogic principles and aspects of delivery that have ensured that these values are delivered.

Keywords: Design Thinking Education, Multidisciplinary Innovation, Design-led Innovation, Critically Reflective Design Thinking

Introduction

Design Thinking is at the heart of this article. Education in Design Thinking is the subject of enquiry and, to a large extent, the methodology employed in that enquiry. There is an increasing body of literature relating to Design Thinking (Brown 2009; Kimbell 2011 and 2012; Nussbaum 2011; Carlgren, Rauth, and Elmquist 2016), and there are multiple definitions offered by academics, practitioners, and professional organisations. They do not all agree, and the literature is mixed regarding both the definition and value of Design Thinking. There is, however, a broad consensus that Design Thinking takes advantage of the designers' attitude (Michlewski 2015) together with design tools in order to democratise creative endeavour in pursuit of user-centred responses in complex situations. Indeed, Carlgren, Rauth and Elmquist (2016) identify five themes with which to frame Design Thinking: user focus, problem framing, visualisation, experimentation, and diversity. In her vociferous attack on Design Thinking, Jen, in her 2017 keynote talk at the ADOBE 99u conference, summarises the folly of its claim, thus: "design thinking packages a designer's way of working for a non-designer audience by codifying their processes into a prescriptive, step-by-step approach to creative problem solving – claiming that it can be applied by anyone to any problem." Notwithstanding the criticism that Jen implies, there are two important factors evident in her summary: that Design Thinking intends to enable "non-designers" to engage in creative activity and that some proponents seek to codify or formalise a process for Design Thinking.

In their study "Design Thinking: An Educational Model towards Creative Confidence," Rauth et al. (2010, 7) define Design Thinking within the teaching context as "a learning model which supports design creativity, utilizing project and process-based learning by emphasising creative confidence and competence." For the purpose of this article, the authors draw on their own experience of Design Thinking, from designers' perspectives, and consider that it a) is very

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much about using design approaches to enable "non-designers" to engage in creative endeavours, and b) does not need to be codified into a prescriptive process.

This article looks back at the development of a programme of study and the influences and factors that shaped it over time. For this reason, contemporaneous sources are used to contextualise the work and, in the article, we use the term "Design Thinking" as shorthand for Design-led Multidisciplinary Innovation.

In 2005 and 2006 a number of reports were commissioned that shed light on different aspects of the UK creative industries covering policy and infrastructural recommendations and emerging trends. These reports included the Cox Review of Creativity in Business (Cox 2005), the NESTA reports on measuring innovation (2006a) and growing and investing in creative businesses (2006b), the Audi Foundation sponsored report on UK design excellence (Whyte and Bessant 2006), and the Work Foundation report on the economic performance of the UK creative industries (Work Foundation/DCMS 2007).

One of the key recommendations from the Cox Review was the establishment of Centres of Excellence that sought to "tackle the issue, in higher education, of broadening the understanding and skills of tomorrow's business leaders, creative specialists, engineers and technologists" (Cox 2005, 4). The Higher Education Funding Council for England established a funding stream to support this, which was also reinforced by growing acknowledgement of the role of multidisciplinary and co-creative activity in design practice and academe, the aforementioned "Design-Thinking." Collectively, these trends indicated that there was:

1. An economic need for graduates who could drive innovation by delivering creativity in business through multidisciplinary projects.
2. Interest in the value delivered by Design Thinking as an approach to addressing complex business challenges.
3. A position about the competencies needed of individuals to thrive within collaborative and multidisciplinary environments.
4. Interest and funding to investigate ways that academia might explore this emerging role for multidisciplinary design to drive economic growth.

In response to these drivers, in September 2007, Northumbria University launched a Master's programme to develop advanced study of collaborative design innovation within a diverse community of graduates coming from design, engineering technology and business backgrounds. It was to be called MA/MSc Multidisciplinary Design Innovation.

After a decade of delivery of this programme, this study seeks to answer the question "what are the critical elements required to deliver Design Thinking education within a changing landscape?" It explores the original design and iterative development of the programme, the contextual factors that influenced this, and the consequent values derived from it by the programmes' stakeholders. Rather than presenting a detailed discussion of the various pedagogic devices deployed in the programme delivery, the study refers to the principles that underpin them.

Methodology

A mixed method approach has been employed in compiling this study, with critical participatory action research at its core. Kemmis, McTaggart, and Nixon in *The Action Research Planner: Doing Critical Participatory Action Research* (2013, 4–5), state that "participants have special access to how social and educational life are conducted in local sites by virtue of being 'insiders.' " They suggest that critical participatory action research

affords special access to, and influence on, the practice, which is beneficial to research as the researchers are very active in "individual and collective self-reflection that actively interrogates the conduct and consequences of participants' practices, their understanding of their practices, and the conditions under which they practice, in order to discover whether their practices are, in fact, irrational, unsustainable or unjust" (Kemmis, McTaggart, and Nixon 2013, 6). They do this rigorously because participants are "profoundly interested in their practices" (Kemmis, McTaggart, and Nixon 2013, 6). In addition to critical participatory action research, which has been used to review well over 100 projects undertaken through the programme with organisations ranging from one-person charities to Fortune 500 corporations, semi-structured interviews and surveys with stakeholders and contemporaneous mandatory institutional programme evaluations have all been used to inform this study.

The act of designing and developing this new programme with Design Thinking at its core was, in itself, an act of Design Thinking. Various models for Design Thinking processes exist, arguably the most popular being that of d-School (Hasso Plattner Institute of Design 2018) which promotes linear activity through five stages: empathise, refine, ideate, prototype, and test. This model provides a helpful structure or set of scaffolding for those who are uncomfortable with the ambiguity inherent in the co-evolution of problem and solution that this sort of work involves (Dorst and Cross 2001). According to Andrea Kershaw of IDEO, "only practice and experience make this way of working a second nature" (IDEO, Design for Europe and Nesta 2017). Indeed, more experienced practitioners are comfortable to move back and forth between the various stages, and not necessarily follow them sequentially. Dorst (2011) highlights how experienced designers tend to seek out the central paradox in any given situation before starting work to find solutions, and in referring to an earlier study, he identifies how the most experienced practitioners, seek to understand the broader contextual issues influencing the central paradox. In the case of this study, the main protagonists were highly experienced practitioner academics with a deep understanding of the many institutional and contextual issues surrounding the central paradox: educating across disciplinary silos. They therefore started from a position of deep empathy, with well-defined questions, and began the process of developing the programme with the prototyping and testing stages, delivered through pilot projects, which allowed the team to establish empathy with the wider stakeholders, refine their understanding of the problem-space, and ideate from there. Additionally, it is the practice of the team involved in the creation of this programme, that each project should conclude with an "unpack" phase—an opportunity for collective reflection on practice. We could term this "Critically Reflective Design Thinking."

Taken at the macro level, each presentation of the programme is merely another prototype tested by the incumbent cohort, tutors, and participating external partners. What emerges from these subsequent deliveries is a body of tacit knowledge and a refined programme responsive to the prevailing external conditions and contextual "curriculum" that is delivered by the partners' topical concerns.

Since its inception, there have been, including the pilot, four formal iterations of the programme. The article is presented as a chronological review of each iteration, drawing overall conclusions at the end.

Part 1: Pilot Studies

In order to gain an understanding of the appropriate pedagogic approaches and to gain insights from students, the team devised and ran a series of six-week pilot projects in collaboration with multinational partners: Lego, Hasbro, Philips, and Unilever (all leaders in their respective fields and early-adopters of multidisciplinary team-based product development). Teams of

undergraduates studying industrial design, business marketing, and engineering technology worked together on client briefs under the guidance of the programme development team and were observed by an independent research assistant. The results of these projects reinforced stereotypical viewpoints about the working practices of different disciplines and the thinking styles that they adopt, as described by Roger Martin of the Rotman School of Management (Dunne and Martin 2006). These were also evident in the academic team developing the programme. Additionally, the pilots revealed a number of key insights that allowed the team to establish three principles that needed to underpin the programme going forward:

- Create physical and psychological environments in which creativity would be nurtured; in order to express themselves and their disciplinary expertise, or to question that of their peers, participants needed a suitable "safe-environment" in which to learn.
- Develop a community of practice in which a "common language" would be learned; significant potential for misunderstanding could arise from the specificity of meaning attributed to key terminology as it relates to the different disciplines.
- Promote shared values through developing self-awareness in pursuit of cooperative learning; dealing with the inherent ambiguity of projects with a more disruptive intention can be unsettling when the scope of exploration is less clearly defined.

The design students involved in the pilots were confident dealing with the inherent ambiguity in the projects because they had experience of this from their prior studies. This, in itself, presented challenges within the groups around leadership, assumed responsibility, encouraging equal participation, and so forth. Additionally, Design-Thinking literature emphasises the importance of rapid experimentation and "failure" in pursuit of knowledge or as "learning in disguise" and, indeed, the team's own research and professional practice experience reinforced this. This too represented a challenge for the student participants who were conditioned by their prior educational experience to pursue "right first time" solutions. The programme was, therefore, built with the aim of establishing a community of practice within which understanding was nurtured and freedom to experiment, to "fail," and to create were celebrated. Pedagogically, the team determined that through committed, collaborative engagement in a creative, explorative activity, deep, cooperative learning is achieved, resulting in increased creative-confidence. Johnson and Johnson (1987) suggest five elements of cooperative learning: positive interdependence, individual accountability, face-to-face interaction, social skills, and processing. They saw these as essential for effective group learning, achievement, and higher-order social, personal, and cognitive skills (e.g., problem solving, reasoning, decision- making, planning, organizing, and reflecting). Creating a programme based around these principles was fundamental, but a radical departure from the norm and contrary to the prevailing Higher Education climate in which risk-taking, and particularly failure, were counter-intuitive when pursuing institutional requirements to achieve "good degrees" and high-grade attainment. The resultant programme was designed to provide a framework within which experimental group-based projects, connected with external partner organisations, formed the primary vehicle for learning the purpose of which was personal development rather than acquisition of specific, pre-determined knowledge or skills.

5. **Part 2: Multidisciplinary Design Innovation 2008–2013**
6. **Context**
7. Resulting from the pilot studies and based upon the socio-political and economic circumstances outlined in the introduction, the Master's programme was designed to be intensive, delivered on- campus over three semesters, and in close partnership with external organisations. It welcomed a multidisciplinary cohort of students responding to real-world challenges working under the guidance of a multidisciplinary team of academics. The stated intention of the programme at this time was to create graduates who:

1. Developed the personal capabilities to: a) realise valuable design-thinking processes and methodologies; b) recognise and articulate creativity through new common language for collaborative practice; and c) tolerate ambiguity by framing complex problems and situations to allow innovation to occur.
2. Engaged externally, through practice to: a) promote discourse between students and external organisations and audiences in order to validate and contextualise their work; and b) communicate the value of this approach to innovation through online and physical publication and exhibition.
3. Establish a reflexive practice to: a) recognise and articulate the richness of personal motivation as a focus for lifelong learning; and b) encourage self- direction and aspirations towards social responsibility and sustainable development.

Programme Structure

Each semester comprised of a large project module, a personal development module, and contextualising modules in the complementary subjects—"Understanding the Business/Design/Technology Context" (Figure 1). The contextual modules ran through the first two semesters and were intended to enable students to make the connection between theory and practice, exposing them to the language and practices of the host discipline.

Problem-based, co-operative learning was fostered through three, semester-long modules— Familiarisation Projects, Experimentation Projects, and Integration Projects—through which students explored problem and solution spaces.

These project modules allowed students (and staff) the freedom to explore and learn collaboratively through projects with commercial, public, and third-sector organisations. In the early part of the first semester, the projects were internal, based around personal projects and theoretical models; where students were initially given a "safe environment" (Bailey and Smith 2010) in which to orientate themselves to the demands of multidisciplinary working and to develop the self-awareness necessary to separate "self" from "team." In the second, they worked with a number of external clients on short projects (two to three weeks typically) whilst in the third, separate, smaller teams had their own client project to manage themselves. Over the course of the three semesters, the role of the client in the project increased as the students became more comfortable with team-working and innovation practice approaches and were better able to concentrate on the project, the client relationship, and delivering real value in projects of genuine importance to the client. These final semester projects were twelve weeks in duration.

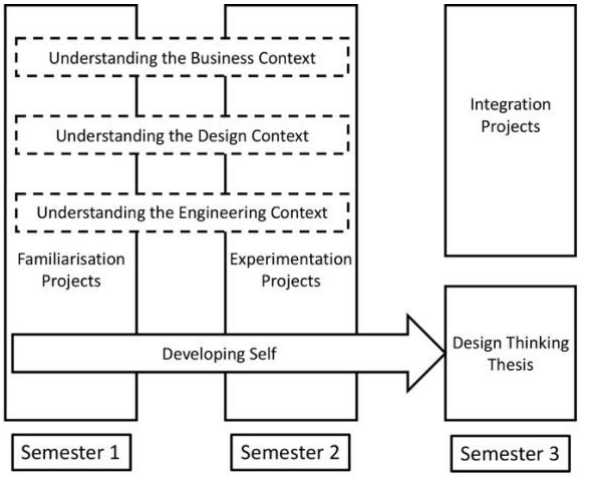

Figure 1. The 2008 Programme Structure
Source: Bailey and Spencer

From the outset, acknowledging the fact that innovation happens when individuals work at the edges of their disciplines, or where disciplines intersect (Johansson 2006), there was the expectation that students would work outside their comfort zone. To support this, the programme formalised the self-reflexive approach through the module "Understanding the Interdisciplinary Self," which allowed all students, individually, to relate their project-based experiences to theory so that they might understand how they could contribute to the multidisciplinary team whilst simultaneously recognising that their behavioural traits and those of their peers were not uncommon. This strand fed into their Design-Thinking thesis, in which students explored and defined their personal position during the final semester. Students could choose whether to pursue an MA or MSc award based upon the methodology adopted in their final semester projects.

Assessment Strategy

The programme team knew that it would be essential to encourage students to adopt an experimental approach in their studies, and this would require a shift in emphasis from the norm in design education, supporting experimentation and growth rather than simply rewarding the delivery of designed outputs. The assessment and feedback-for-learning for this new Master's programme, therefore, needed to provide a supportive structure that would encourage experimentation and reward learning "at the edges" of knowledge for all students.

In order to promote risk-taking and learning from failure, the team proposed that the programme should be assessed only as pass or fail. This proved particularly difficult to validate and eventually, in order that students could graduate with a classification, the approach was adopted only for the first two semesters, with the third graded. Inherent in this was a risk that the final semester would become "all or nothing" but in practice, the team saw that the learning culture and behaviours established in semesters one and two carried through into semester three. The self-reflexive focus engendered through the "Understanding the Interdisciplinary Self" module was critical to the success of this approach. Students were encouraged to be aware of their individual contributions, where

they could afford to take risks in pursuit of the project objectives and how to take best advantage of collaboration; an approach supported by the likes of Winkel (1999) and Boud, Cohen, and Sampson (2014).

A "learning eco-structure" (Figure. 2) has been used to support students' growth beyond academic attainment. Formal assessment in semesters one and two was of the individuals' learning derived from the project activities undertaken. This was presented in a "Personal Portfolio of Practice," an account of what took place and a reflection on the consequent learning related to both theory and practice. Informally, assessment was established in the structure and culture of the community of practice and took three forms:

- Students continually assessed themselves and each other through their practice. Just as each student was a recipient of assessment and feedback, they were a giver as well, taking on the role of both co-operative-learner and tutor.
- Tutors, in supervising the projects, often took a participatory role in on-going co- creative practice activities. This established trust between the students and tutors as well as providing on-going formative feedback opportunities.
- Clients played an informal assessment role as well, providing critique and validation from a professional standpoint. Students placed particular value on this external validation and the confidence that it built.

These informal aspects of assessment established a climate within which the majority of students flourished and were driven to deliver high quality project outputs (the sort that would have received excellent grades had they been assessed against typical design education criteria) in order not to let themselves, each other, or the clients down. Whilst the subsequent iterations of the programme saw slightly different assessed components, the assessment strategy, and principles that underpin it, has remained the same throughout.

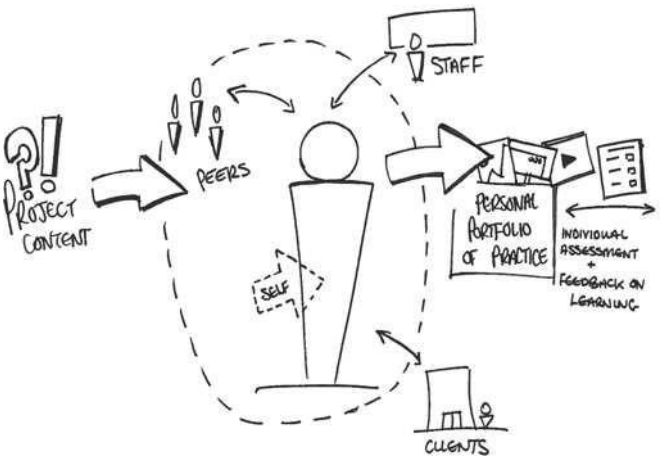

Figure 2: The Learning Eco-Structure
Source: Illustrated by Nate Sterling 2015, Based on Authors' Original

Critique

In the first iteration of the programme, ninety-seven students graduated over a five-year period, with twice as many designers in the cohort as business and technology graduates combined. Several other disciplines were also represented, with Politics, Education, Social Sciences, and Fine Art all involved.

For the first three years, European Regional Development funding was deployed to provide studentships to help students afford to study. This funding existed to promote knowledge exchange to support regional small- to medium-sized Enterprises (SMEs) in establishing an innovation culture, developing new products, and/or creating new employment. This was beneficial in enabling the programme to launch and attract early cohorts. However, the regional SME focus inhibited the team in running projects with as many large corporations as they had originally envisaged. In hindsight this has proved to be a very good thing because overall the balance of project collaborators has been fairly evenly split among regional, national, and global organisations, and across sectors. Consequently, staff and students have had opportunities to understand the relationships between global trends and local action. Indeed, surveys of alumni from this period have indicated that the projects undertaken with smaller, local organisations, and particularly social enterprises and charities, helped them understand the real value of their work and the contribution that they, as individuals, could make.

> For me I think the biggest impact on my creative confidence is that the charities and social enterprises that we worked with tend to be smaller and because of that they are able to implement the changes suggested by MDI much faster, I think being able to see your work change a client for the better can really help. You also don't have as much self-doubt when working with smaller companies. (MDI graduate surveyed in 2018)

The suite of projects undertaken under this funding provided data that enable the team to identify an eight-stage approach to design-led innovation projects undertaken with SMEs (Bailey, Smith, and Aftab 2013).

Significantly, a review of projects at this time identified that those that delivered greatest perceived value to each stakeholder were those where co-creation of a "common purpose" as part of problem-framing was achieved, thereby giving each stakeholder a sense of ownership and responsibility for solution creation and implementation.

Values (to Student, Partner Organisation, Society, and Academia)

Contemporaneous reviews of student, partner, and colleague feedback highlighted that the programme offered different values and related differently to different stakeholders.

Table 1: MDI 2008–2013 Stakeholder Values

Stakeholder	*Valu e*
Students	Part-funding which helped them commit to postgraduate study that afforded the opportunity to be experimental and work directly with “industry.”
	Developing a CV of innovation practice experience with client organisations comprising multiple clients, across a different sectors and business types.
	A new creative confidence and self-awareness resulting from experiential learning and extensive professional development. They had also learned how to collaborate with others or learn new skills in order to make up for any perceived deficiencies.
	Diverse graduate destinations: roles within larger organisations who were adopting Design-Thinking; SMEs in roles that took advantage of their broader perspective (often an asset in a small business where employees are required to fulfil multiple roles). Almost 10% of graduates started their own businesses and a similar number registered for PhDs.
Partner Organisation	Benefitting from access to new ways of working with multiple disciplines to define and solve complex problems.
	Networked knowledge and cross-fertilisation of process knowledge which was informal and happened as a consequence of students and academics taking tacit knowledge developed in one context and applying it in another.
	Access to new talent with the course offering a protracted selection process through which potential employers could evaluate students’ employability over the duration of a project.
Society	Innovative solutions from projects responding to a social or civic concern with local government, public-sector, community groups and charities resulting in a direct and meaningful contribution to society.
	Graduates equipped as positive agents of change as a result of tackling challenges faced by organisations in the Community and Voluntary sectors.
	The Regional Development Agency studentships delivered a series of specific, measurable outputs related to business growth; e.g. 48 innovation studentships delivered, 40 SMEs supported and 7 jobs created/safeguarded.
Academia	Tacit knowledge of the programme team, developed and tested through close industry engagement ensured that the founding principles and approaches of the programme remained current and valid.
	Contemporary practice and business knowledge was brought into the programme by partnering organisations including a number of specialist innovation agencies such as Park Innovation, Matter, Plan, Impact Factory.
	Pedagogic studies were published about the design and delivery of the programme.

Source: Bailey and Spencer

Programme Deficiencies

In Design Thinking, the value to be gained from testing a prototype is only truly realised if the testing is honest and critical. In the same way that the students were encouraged to prototype their ideas, externalise them, trial and refine them, we recognised that each iteration of the programme offered an opportunity for improvement based on collective critical reflection. Over the period 2008–2013, there were aspects of the programme that did not work as well as the team had intended. These offered a platform for future development.

The programme failed to engage with technology-futures in a meaningful way. The aim had been to introduce students to newly emerging technological developments in a way that would enable them to conceptualise future solutions taking advantage of breakthrough or far-horizon technologies. This did not happen, partly because the nature of the partners' projects did not offer this scope, and partly because staffing restrictions within the Engineering Faculty limited the breadth (but not quality) of knowledge coming into the curriculum.

The Context modules were exclusive to those students who had not studied the particular subject as undergraduates. Each student took only two of the three modules, and this was unhelpful to overall cohort cohesion and proved difficult to administer when students did not see themselves as fitting neatly within any one disciplinary "box." In fact, it was counterintuitive to them when the declared purpose of the programme was to promote multidisciplinary collaborative working.

"Weaker" students tended to exploit the pass/fail assessment, and whilst there was peer assessment within the final semester assignments, this was not formalised and resulted in some students "coasting" and taking advantage of other students' efforts. It should be emphasised that this happened in very few instances but was, nonetheless, a concern.

In spite of an assessment design that was intended to promote experimentation, project outputs were not always as ambitious as we would have hoped. Whilst assessment plays one part in driving behaviour, there are multiple other factors at play: topic, client ambition, constitution of the team, etc. In contrast with the view expressed by students about the value of working with smaller organisations where their work had more potential impact, it was clear that the larger the organisation was, the greater the client ambition and the more adventurous the student response.

The need to provide a pipeline of project partners and briefs meant that projects were purely opportunistic in the way that they were framed; they were not driven by, or contributing to, any specific research agenda beyond the general pursuit of knowledge regarding the pedagogy and practices of multidisciplinary innovation.

The methodologies employed within the projects were very free-form and not often rigorously theoretically anchored: this helped projects progress swiftly and encouraged the development of exciting, sometimes unexpected, approaches. At this time, the programme team did not view the programme as a research site; they were not equipped to capture all that was going on or methodical in translating this into their own published methods. This was a missed opportunity.

Part 3: Multidisciplinary Innovation 2013–2017

A Changing Context

Additional to the values and deficiencies previously reported, in December 2011 two reports outlined the UK government's design priorities, initiatives, and the actions considered necessary to support research and innovation for economic growth (Design Council, 2011; UK Government, 2011). Taken together, they revealed three trends significant to the role and value of design in multidisciplinary innovation: 1, Design supports economic growth and social improvement through two distinct and discrete roles - a facilitatory leadership role of adopting designerly attitudes and approaches and the executional role of designers designing; 2, There is aneed for greater understanding about, and utilisation of, design-led approaches to support economic growth and social transformation; 3, There is a lack of knowledge and practice understanding about how to utilise diverse networks to leverage distributed creativity and intelligence.

In response to these trends and our critique of the programme, a second iteration of MDI was developed and validated. This version was based on the standpoint that multidisciplinary design- led approaches can lead a multi-stakeholder network to develop a common purpose and collective vision through the exploration of project challenges and that this will lead to greater potential for positive change by design.

The Programme Redesigned

Three significant changes distinguished the redesigned programme: (1) a move from 'Design (discipline) led' to 'design-led' (as a set of values, behaviours, activities and resources) multidisciplinary innovation; (2) a more mature relationship with external collaborators, which moved the approach to projects from consultative to co-creative (Bailey, Aftab and Smith 2015); and (3) a recognition of the value of the programme as a research site through which the team could investigate both pedagogic and practice issues. The aim of the programme remained the same, as did established elements of environment and practice.

In response to the changing contextual factors and the critique presented in Part 2, the programme structure, content and assessment strategy were all modified. The programme name was changed; market research indicated that business graduates were put off by the word 'design' in the title. This, together with the move away from 'Design (discipline) - led' encouraged the team to rename the programme MA/MSc Multidisciplinary Innovation (the MDI acronym and brand still just about worked). The purpose and ethos of the programme remained the same.

Programme Structure

The new structure (Figure 3) was created to deliver an enhanced curriculum through four knowledge strands: Planning and Professionalism (core business knowledge), Self and Community (reflective practice and team dynamics), Science and Technology Futures (emerging science and technology), Methods and Communications (designerly approaches to research and facilitating innovation). These strands effectively replaced the 'context modules' but were core to all students and ran through project modules providing an integrated learning experience, with projects the 'laboratory' within which theory was put to the test. Whilst each project remained un-graded, the Portfolio of Practice assignment for each module was now graded. Again, the focus of the Portfolios of Practice was very much on establishing reflexivity but with greater emphasis being placed on students' abilities to tie their own and their teams' practice back to the underpinning theory.

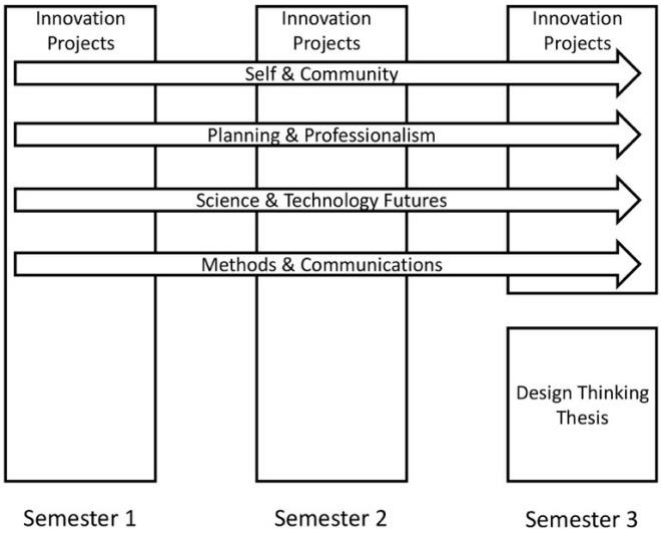

Figure 3: The 2013 Programme Structure
Source: Bailey and Spencer

The Emergence of Integrated Academic Practice:

Through this structure, a model of Integrated Academic Practice (IAP) emerged and was refined (Bailey and Smith, 2016). It suggests that project-based activity with external partners can offer a situation that promotes high-quality, pedagogically sound, 'authentic' learning, whilst offering a research site from which to gather data and validate new knowledge (Figure 4). In order to take full advantage of IAP, projects need to be established with clear scope that acknowledges the importance of research as well as the desired innovation outcomes and associated learning. Furthermore, a number of resources and conditions need to be in place to take advantage of the opportunities presented by IAP.

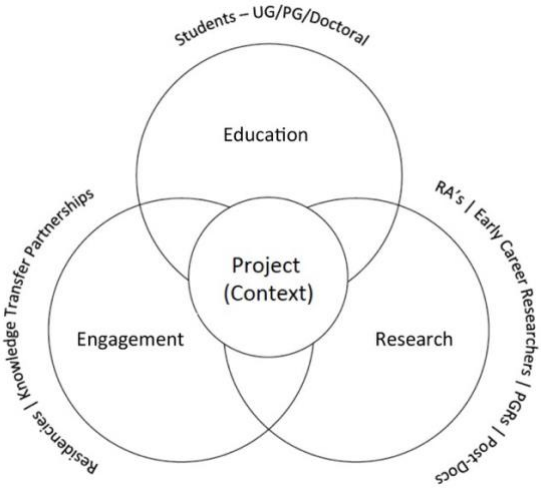

Figure 4: A Model of Integrated Academic Practice
Source: Bailey and Smith 2016

One such resource is the Innovator in Residence (IiR). The team saw that a number of student projects fell short of delivering their true potential to partner organisations due to a lack of available, appropriate university or partner resource. As the students moved on to their next project, partners were left with a glimpse of a better future, but no resource with which to help them achieve it. The role of IiR was conceived to provide this capacity and a practice-based resource that would give both the project implementation and the research potential greater reach. The IiR role provides an opportunity for MDI graduates to remain with the programme team, supporting projects whilst establishing their own professional practice and receiving mentorship from the academics. In turn, the IiRs help mentor the incumbent MDI students. In this way, the IiRs have become an invaluable connecting-tissue in the community of practice that the programme has sought to cultivate. A significant beneficial outcome of engaging IiRs is that the incumbent students can see the fruits of their work starting to manifest in implemented strategy and delivering meaningful change within organisations. When surveyed, graduates suggested "[They] showed me how valuable my work in the team was, no matter what my grades were. I think they really helped me to see MDI as a job, and not as a course, and to an extent, to value my projects output and outcomes, instead of my grades, which I believe helped me to grow and become a professional instead of being just a student. I felt purposeful and useful." And "[It created a] sense of pride when they would come ask us for stuff around our projects that they were now working on, I think having a staff-member ask your opinion and knowing it's having an input on what they're doing boosts your confidence".

Critique

This iteration saw a further sixty-seven students engage with over fifty different organisations, from the smallest local charities to global Fortune 500 corporations.

Values (to Student, Partner Organisation, Society, and Academia)

Again, a review of contemporaneous student, partner and colleague feedback and mandatory institutional programme monitoring documentation identified that similar benefits carried forward from the first iteration of MDI, but highlighted additional values to the different stakeholders (Table 2).

Table 2: MDI 2013 – 2017 Stakeholder Values

Stakeholder	*Value*
Students	Diverse projects allowing appreciation of underpinning theories and core values of what they were learning, independent of context and application.
	Making a difference with smaller not-for-profit organisations. Students felt that they were helping real people through real projects thereby developing their "Designerly Purpose" (Bailey, Aftab, and Duncan 2014).
	Global perspective gained by projects with multinationals, which helped them see their potential within the context of a world-stage.
	IiRs as "staff who valued our opinions and ideas."
Partner Organisation	Partnerships built over time allowing longitudinal suites of projects developing knowledge-creation and staff-development (through engaging with design-led practice). This afforded the programme team to be proactive in sharing emerging knowledge (Bailey, Aftab, and Smith 2015).
	Innovators in Residence who provided opportunities to develop and execute projects and embed design-led practices in organisations.
Society	Social innovations delivered through responsible innovation projects with charities, not-for-profits and larger, commercial, organisations.
	A Responsible Innovation position as a set of guiding principles in all projects ensuring that the purpose of innovation, whatever the context, should be about delivering positive societal change (Bailey, Spencer, and Sams 2016).
Academia	The collective research thrust of the programme team was brought together to form a Design-led Responsible Innovation Practice Research group, addressing the questions: How can we promote design-led responsible innovation within organisations as a driver of positive change? What knowledge, methods, tools, attitudes, behaviours, structures, education are required?
	The research capacity of the group grew, initiating 7 PhD studies, engaging a number of Research Associates through specific funded projects.
	A research partnership between the Business and Design Schools emerged, recognising a convergence in interest surrounding the relationship between design-led approaches and entrepreneurial leadership.
	Partners have shared contemporary practice, knowledge and know-how as well as contextual market knowledge thereby helping maintain currency of programme knowledge and formation of the Responsible Innovation position.
	Collectively, between 2013 and 2017, the team published 21 papers and articles relating to both disciplinary (or multidisciplinary) practice knowledge and pedagogy.
	The team's design-led multidisciplinary practice and IAP approaches were adopted as central methodologies in three collaborative research programmes: AHRC Creative FUSE NorthEast and ERDF Creativity Works (total combined value c£4m) and ESIF Horizon 2020 International GETM3 programme (c €1m).

Programme Deficiencies

An honest critique of MDI 2013–17 revealed certain deficiencies from which, again, to develop the programme further.

"Technology Futures" remained a difficult area. The team concluded that the scope of technological advances is so diverse that it is not possible to deliver a coherent and timely curriculum that has relevance to the ongoing projects. It is most beneficial to bring in expertise on a project-by-project basis.

Projects occasionally became process-driven and lacked spontaneity and drive leading to some 'safe' solutions where students took comfort in the activity of pre-prescribed methods, planning and team organisation than confront the ambiguity and uncertainty presented by the subject of the project. This led to wasted time and 'safe solutionism' when the project deadline loomed. This could be attributed to a greater emphasis on, and availability of, contemporary theory as more literature was published in this space and general awareness of Design Thinking in business, and on-line tools to support it, emerged. The academic attainment of students joining the programme during this period was also higher, and a more theoretically grounded curriculum was delivered resulting in students taking a more academic approach in some projects. This was simultaneously beneficial and disadvantageous because it is important to maintain a balance between desk-based research and the sort of generative, practice-based activity that encourages learning through failure and stimulates genuine breakthrough innovation – this was seen to be missing is some projects.

In contrast with this concern, external stakeholders and partners were very enthusiastic in their praise of the students and their work: they appreciated the depth and variety of thinking. The programme has failed to communicate the many great stories emerging from this work.

Tim Brown, suggested that T-shaped individuals were not "jacks of all trades" and yet the MDI programme in this period became, in some respects, all things to all people. Whilst this could be an asset, it affected the clarity of message that the programme was able to project and therefore the students and businesses it was able to attract.

Part 4: Multidisciplinary Innovation 2017 Forwards

A New Context

In response to emerging trends and our critique of Multidisciplinary Innovation practice and education, a third version of the programme was developed based upon the premise and promise of design-led multi-disciplinary *responsible* innovation practice.

The Design Council's response to the UK government's Industrial Strategy Green Paper, "Design: Delivering a new approach to growth," was influential. This presented a Growth Blueprint that aimed to deliver resilient, inclusive and sustainable growth by providing a design- led bridge between initial ideas and innovation (Design Council 2017; UK Government 2017). Simultaneously, Innovate UK, the UK government's innovation agency, started funding early- stage design interventions through "strategic design" as a means to guiding the innovation journey. Both reinforced MDI's next iteration.

The emergence of "responsible innovation" (RI) as a fundamental principle of MDI and the programme's research into what it is (Bailey, Spencer, and Sams 2016) and how to teach it (Spencer et al., 2017) introduced a new set of contextual considerations. Taking a responsible innovation perspective does not have to be at odds with design-led agency

for economic growth or those enabling societal transformation and citizen empowerment. Owen, Bessant, and Heintz (2013, 27) set the context for RI: "innovation has not only produced understanding, knowledge, and value (economic, social, or otherwise), but also questions, dilemmas, and unintended (and sometimes undesirable) impacts."

Collectively, these drivers reveal a number of trends significant for the role and value of design-led multidisciplinary innovation: 1) an inclusive early-stage design-led approach can help define appropriate targets of responsible innovation and explore the rights and roles of the public within them; 2) inclusive early-stage design-led approaches can also inform strategic decision making by developing, with a multi-stakeholder-network, an understanding of innovation impacts and potential consequences; and 3) the facilitatory role of design can be usefully deployed to provide a bridge between early ideas, stakeholders and different, potentially competing, agencies.

The Programme Redesigned

The IAP model allows the programme to be more explicit about the research that is conducted through the students' participation in challenge-focused, innovation-seeking projects, intelligently situating academic expertise, funded research engagement, and active student learning with the priorities of external businesses and communities as the basis for research that explores approaches to inclusive front-end innovation. It highlights the reciprocal values that benefit students, partners, society, and academia in project-based knowledge co-creation and sharing. Focussing on RI has not limited the scope of project partners or project topics but, rather, added a particular lens through which the programme can seek to support organisations and communities to develop resilience through establishing the capabilities to respond to challenging situations by scoping and defining new growth opportunities using design-led practices.

Structure

This latest iteration of the programme is a collaboration between Northumbria University's Schools of Design and Business and is located in an off-campus design business centre. Students enrol from any disciplinary or professional background to work in a research and innovation consultancy-style learning environment. RI capabilities are developed through a number of core programme principles that capitalise on: connected strategic projects with partner organisations, communities and networks; a community of practice with purpose under the guise of the design- led RI practice research group, which provides a safe environment and common-language for practitioners and researchers; the creativity of a connected and networked core multidisciplinary team; utilisation of compelling practice outputs to drive ambition and foster co-creation amongst diverse groups; valuing project outputs as data in order to develop strategy to support social and organisational transformation (Spencer et al. 2017).

The new programme structure is directly derived from the IAP model, using three integrated modules, each of which hosts a specific macro research question whilst simultaneously providing a framework within which co-creative, externally connected projects are undertaken. These projects, undertaken in teams, are conducted alongside academics, IiRs and researchers; generate knowledge about the project stakeholders' immediate and future challenges; and produce strategic insights and assets (designs for

products, systems, services, strategic plans, etc.) (Figure 5).

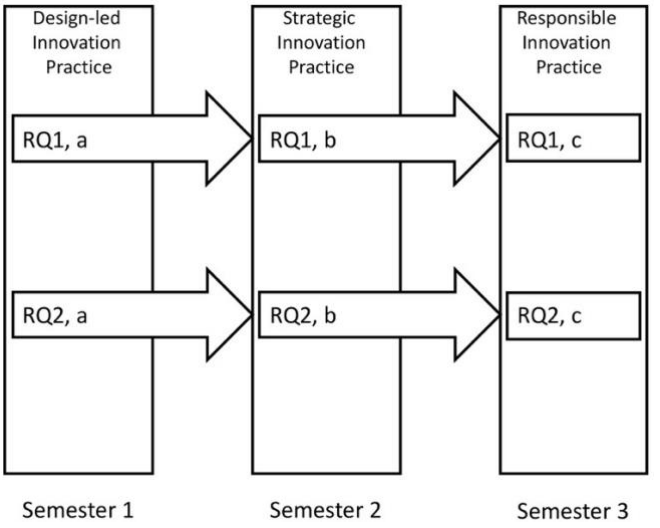

Figure 5. The 2017 Programme Structure
Source: Bailey and Spencer

Module One, "Design-led Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional develop?" and "What approaches, methods, and tools enable effective networked responsible innovation practice?"

Module Two, "Strategic Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional lead within organisations and communities?" and "What knowledge and advanced approaches support networked responsible innovation practice to deliver strategic value?"

Module Three, "Responsible Innovation Practice," explores the research questions: "How does the multidisciplinary entrepreneurial professional position them self reflexively within a global perspective?" and "Does networked responsible innovation practice enhance resilience by leading strategic organisational transformation and is this an effective and democratic methodology for producing an understanding about how to address global challenges?"

The new programme is designed to develop specific innovation practice capabilities, generate the creative confidence to design and facilitate co-creation, and enhance the employability of graduates.

Critique

The latest iteration of the programme has only been delivered for one cycle and a thorough critique at this stage would not be possible. In addition, a major research programme, Creative Fuse North East (CFNE), played a significant part in the students', and academics', practice through this presentation (Creative Fuse North East 2017). This allowed the students to engage very closely with micro-SMEs and independent professionals, allowing their work to deliver significant impact for the beneficiaries.

Values (to Student, Partner Organisation, Society, and Academia)

Table 3 presents early indications of value for the stakeholders derived from this latest iteration of the programme.

Table 3: MDI 2017 Stakeholder Values

Stakeholder	*Value*
Students	Direct impact on small enterprises that they supported and feeling simultaneously trusted and valued to advise, but equally supported by academics and, especially, Innovators in Residence.
	Some, very high achieving, students also felt a clear sense of being a valued member of a research community.
Partner Organisation	Co-creation and strategic nature of engagement, together with time to focus on their future situation rather than the immediate present needs (this observation relates to the CFNE beneficiaries)
	Networked knowledge and expertise provided by engagement with the MDI community of practice.
Society	Whilst it is too early to draw any direct conclusions in this regard, the purpose of the CFNE programme was to drive economic growth in the region through developing and deploying innovation capability and capacity enhancing interventions MDI students, academics, researchers and IiR were involved in delivering support to 21 different enterprises through this programme. Initial independent evaluation of the results is favourable.
Academia	As a direct result of the work conducted through the CFNE programme the team's practice and research has been focussed on developing rapid responsible innovation readiness and support activities. This has laid foundations for further publication and bidding activity which will see an adaptation of the approaches developed through CFNE being deployed by the team with enterprises in Armenia.
	During this period, a further dimension of the team's practice matured and was published. This identified certain value-frames within which engagement with design-led responsible innovation practice delivered through IAP present value to partnering organisations.

Source: Bailey and Spencer

Programme Deficiencies

Again, with only one cohort through the new programme, it is unwise to draw many conclusions. One observation that will guide the team as the programme matures is that, whilst academic attainment remains very high, the nature of the final semester assessment may be too complex and requires some revision. The team will continue, as they have through the life of the programme, to view each presentation of the programme as an iteration to be treated as a prototype in testing, to critically reflect upon its delivery and dynamically adapt it to address emerging situations and opportunities.

Conclusion

This article presents and reviews the development of a single postgraduate programme to consider the critical elements required to deliver Design Thinking education. From

inception, the programme was concerned with developing graduates who could drive innovation by delivering creativity in business through multidisciplinary projects. To fulfil this ambition, the academic team, rather than teaching about Design Thinking, sought to establish the environment, curriculum, theoretical scaffolding, pedagogic devices, and project collaborations that encouraged Design Thinking practices and behaviours. In this regard, the programme aligns to Kimbell's (2011) definition as it establishes Design Thinking as a cognitive style and as an organisational resource to its project collaborators.

This review has shown that, by delivering an offer that is different and distinctive from other commercial and support services, education can simultaneously establish the capabilities in its students that support Design Thinking practices and behaviours and act as a project partner to a variety of external organisations. There are three components that appear to have been important in this regard: 1) resource (academics, Innovators in Residence, researchers, and students) and management of that resource to coordinate with external stakeholders in order to engage with, and attempt to better appreciate, complex situations; 2) the agenda to develop knowledge about design-led approaches to responsible innovation through practice-based generative research, supported by an independence from client objectives and deliverables; and 3) remaining adaptive to political, socio-cultural, and economic factors in order to frame the dynamics of complex situations, thereby grasping the difficulties, conflicts, and opportunities experienced by all stakeholders.

The critical review presented in this article highlights some of the challenges of establishing Design Thinking practices and behaviours amongst a cohort made from multiple disciplines, where individuals have diverse prior learning experiences and expectations. One such challenge relates to recognising when individuals, groups, or the entire cohort begin conceptualising Design Thinking as a procedural, step-by-step approach to solving any problem. In-project coaching and formalised review sessions are mechanisms that develop reflexivity and encourage practitioners to continually question what they are doing and why they are doing it. Attempting to avoid a codified facsimile of a design process, the programme seeks to nurture creative confidence. Whilst addressing a given project situation, this relies on creating an environment that encourages exposure to, and experimentation with, multiple approaches and a fluidity of accessing, adopting, and adapting design method resources.

Further research to understand if the institutional, regional, and national factors that have helped shape this progamme are evident in other programmes that seek to teach Design Thinking is required. However, what this study has shown is that paying close attention to the relevance of an educational programme to its various stakeholders and understanding the policies and trends that influence those stakeholders can enable a heightened understanding of the context within which the programme must operate. Viewing the creation and presentation of the programme as an exercise in "Critically Reflective Design Thinking" creates a mind-set that ensures that the programme team are continually mindful of the changing context, and coupled with close external partnerships, this ensures relevance and currency of the curriculum to its context. In each manifestation of the programme, the team has tried to bring forward the most effective aspects of the previous one and use these as a platform for iterative development responsive to changing contextual factors. As such, the programme is never fixed and will continue to adapt and grow.

REFERENCES

Bailey, Mark, and Neil Smith. 2010. "Safe Environments for Innovation-Developing a New Multidisciplinary Master's Programme." In *DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education - When Design Education and Design Research Meet…,* edited by C. Boks et al., 60–65. Strathclyde: The Design Society Institution of Engineering Designers.

Bailey, Mark, Neil Smith, and Mersha Aftab. 2013. "Connecting for Impact: Multidisciplinary Approaches to Innovation in Small to Medium Sized enterprises (SMEs)." In *FormAkademisk - Research Journal of Design and Design Education 5 (2),* edited by Liv Merete Neilsen, 1863–76. Oslo: DRS//Cumulus.

Bailey, Mark, Mersha Aftab, and Trevor Duncan. 2014. "New Design is Bigger and Harder-Design Mastery in a Changing World." In *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations,* edited by Erik Bohemia, 443–48. Strathclyde: The Design Society Institution of Engineering Designers.

Bailey, Mark, Mersha Aftab, and Neil Smith. 2015. "Hidden Value-Towards an Understanding of the Full Value and Impact of Engaging Students in User-Led Research and Innovation Projects Between Universities and Companies." In *Proceedings of the 3rd International Conference for Design Education Researchers*, edited by Erik Bohemia, 290–307. Helsinki: Aalto University.

Bailey, Mark, and Neil Smith. 2016. "Making it Work; Integrated Academic Practice." In *Proceedings of 20th DMI: Academic Design Management Conference; Inflection Point: Design Research Meets Design Practice,* edited by Erik Boya, 2346–63. Boston: The Design Management Institute.

Bailey, Mark, Nicholas Spencer, and Phil Sams. 2016. "What on Earth is Responsible Innovation Anyway? – Making it Happen." In *DS 83: Proceedings of the 18th International Conference on Engineering and Product Design Education (E&PDE16), Design Education: Collaboration and Cross-Disciplinarity,* edited by Erik Bohemia, 234–39. Strathclyde: The Design Society Institution of Engineering Designers.

Brown, Tim. 2009. *Change by Design: How Design Thinking Creates new Alternatives for Business and Society*. New York: Harper Collins.

Boud, David, Ruth Cohen, and Jane Sampson. 2014. *Peer Learning in Higher Education: Learning From and With Each Other*. London: Routledge.

Carlgren, Lisa, Ingo Rauth, and Maria Elmquist. 2016. "Framing Design Thinking: The Concept in Idea and Enactment." *Creativity and Innovation Management* 25 (1): 38–57. https://doi.org/10.1111/caim.12153.

Cox, George. 2005. *Cox Review of Creativity in Business.* London: HM Treasury.

Creative Fuse North East. 2017 "Exploring Possibility, Connecting Creativity" *Creative Fuse North East.* Accessed June 2, 2019. http://www.creativefusene.org.uk/.

Design Council. 2011. "Design for Innovation." *Design Council.* https://www.designcouncil .org.uk/sites/default/files/asset/document/DesignForInnovation_Dec2011.pdf.

———. 2017. "Design: Delivering a New Approach to Growth." *Design Council.* Accessed https://www.designcouncil.org.uk/sites/default/files/asset/document/Design%20Coun cil %20Response%20to%20Industrial%20Strategy%20Green%20Paper%202017.pdf.

Dorst, Kees, and Nigel Cross. 2001. "Creativity in the Design Process: Co-evolution of Problem– Solution." *Design Studies* 22 (5): 425–37.

Dunne, David, and Roger Martin. 2006. "Design Thinking and How It Will Change Management Education: An Interview and Discussion." *Academy of Management Learning & Education* 5 (4): 512–23. https://doi.org/10.5465/AMLE.2006.23473212.

Hasso Plattner Institute of Design. 2018. “Design Thinking Bootleg.” *Hasso Plattner Institute of Design.* https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/5b19b2f2aa4a99e99b26b6bb/1528410876119/dschool_bootleg_deck_2018_final_sm+%282%29.pdf.

IDEO, Design for Europe, Nesta. 2017. Designing for Public Services. Accessed February 20, 2018. https://www.ideo.com/post/designing-for-public-services.

Jen, Natasha. 2017. Design Thinking is Bullsh*t. https://99u.adobe.com/videos/55967/natasha- jen-design-thinking-is-bullshit.

Johansson, Frans. 2006. *Medici Effect: What Elephants and Epidemics can Teach us about Innovation*. Boston, MA: Harvard Business Press.

Johnson, David W., and Roger T. Johnson. 1987. *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learning*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Kimbell, Lucy. 2011. “Rethinking Design Thinking: Part I.” *Design and Culture* 3 (3): 285–306. https://doi.org/10.2752/175470811X13071166525216.

———. 2012. “Rethinking Design Thinking: Part II.” *Design and Culture* 4 (2): 129–48. https://doi.org/10.2752/175470812X13281948975413.

Kemmis, Stephen, Robin McTaggart, and Rhonda Nixon. 2013. *The Action Research Planner: Doing Critical Participatory Action Research*. Singapore: Springer Science & Business Media.

Leonard-Barton, Dorothy. 1995. *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation.* Boston, MA: Harvard Business School Press.

Lester, Richard K., Michael J. Piore, and Kamal M. Malek. 1998. “Interpretive Management: What General Managers can Learn from Design.” *Harvard Business Review* 76 (2): 86– 96.

Michlewski, Kamil. 2015. *Design Attitude.* Farnham: Gower.

NESTA. 2006a. “The Innovation Gap.” *NESTA*, October 1, 2006. https://www.nesta.org.uk/report/the-innovation-gap/.

———. 2006b. “Creating Growth.” *NESTA*, April 1, 2006. https://www.nesta.org.uk /report/creating-growth/.

Nussbaum, Bruce. 2011. “Design Thinking Is A Failed Experiment. So What's Next?” *Fast Company*, April 5, 2011. http://www.fastcodesign.com/1663558/design-thinking-is-a- failed-experiment-so-whats-next.

Owen, Richard, John Bessant, and Maggy Heintz, eds. 2013. *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester, UK: John Wiley & Sons.

Rauth, Ingo, Eva Köppen, Birgit Jobst, and Christoph Meinel. 2010. “Design Thinking: An Educational Model Towards Creative Confidence.” In *DS 66-2: Proceedings of the 1st International Conference on Design Creativity (ICDC 2010)*, edited by Toshiharu Taura and Yukari Nagai. 1–8. Glasgow: The Design Society.

Spencer, Nicholas, Mark Bailey, Neil Smith, Jenny Davidson, and Phil Sams. 2017 “What on Earth is Responsible Innovation Anyway? - and how to teach it.” In *DS 88: Proceedings of the 19th International Conference on Engineering and Product Design Education (E&PDE17), Building Community: Design Education for a Sustainable Future*, edited by A. Berg et al. 38–43. Strathclyde: The Design Society Institution of Engineering Designers.

UK Government. 2011. “Innovation and Research Strategy.” *Gov.UK*, December 8, 2011. https://www.gov.uk/government/publications/government-innovation-and-research- strategy

———. 2017. “Building our Industrial Strategy: Green Paper.”

Gov.UK. https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf.

Whyte, Jennifer, and John Bessant. 2006. “Making the Most of UK Design Excellence.” In *Audi Foundation Report.* London: Tanaka Business School, Imperial College.

Winkel, Brian J. 1999. “Formative Assessment During Complex, Problem-Solving, Group Work in Class.” *The Mathematical Association of America MAA NOTES* 49: 120–22.

Work Foundation/DCMS. 2007. *Staying Ahead: The Economic Performance of the UK’s Creative Industries*. London: The Work Foundation.

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APPENDIX 3: Professional practice case study example of design as creative compromise

An example of design as creative compromise is presented drawn from the author's professional practice. In this case, he was responsible for the industrial design of automotive audio equipment which was developed and manufactured by Alpine Electronics and sold as both OEM and after-market equipment. It was not uncommon for the same electronic componentry to be employed in a variety of different products, sold to different auto manufacturers. In one notable instance, a highly advanced after-market unit (Figure A3i.) was re-designed as an OEM unit to be supplied installed in the Rolls-Royce Silver Seraph motor car. For the OEM market, accentuating the technical superiority of the unit was achieved through provision of a multitude of controls, programable functions and applied facia graphics, whilst the same unit, when re-designed for the Rolls-Royce, simply had a number of functions effectively disabled (or factory-set) in order that the facia could have a simplified appearance, in keeping with the rest of the vehicle interior and in particular responding to research which showed that the average Rolls-Royce owner at that time was over 56 years old, male and wore gloves whilst driving therefore needing fewer, larger buttons! In this example, the most dominant creative compromises were between the competing demands of providing access to complex technical functionality and delivering aesthetically pleasing and easily operable solutions to suit a very particular consumer audience.

Progressing from the agreed industrial design concept, itself a temporary form of certainty, (Figure A3ii.) to the installed production unit (Figure A3iii.) involved further compromises in order to achieve reliable manufacturing quality at a suitable cost and in appropriate volumes. In such an example the designer is often the 'owner' of the vision for the end product, they can visualise, both on paper and in their mind's eye how the final design should look, feel and perform. For this reason, they play a critical facilitatory role within the development cycle of the product, shifting from moments of certainty to uncertainty along the journey, all the time gaining and sharing knowledge. At the moment when the development is complete and the product manufactured, it represents a crystallisation of the various technical and artistic inputs that have brought it into being – it is the embodiment of the collective knowledge, expertise and learning and, for that moment, it is certain. Viewed today in the context of today's knowledge about in-car infotainment systems, this 1998 product represents a very incomplete collection of knowledge.

Figure A3i, the original 'fussy' after-market unit

Figure A3ii, the designer's concept rendering for the re-design

Figure A3iii, the final manufactured item installed in a Rolls-Royce

APPENDIX 4: Research Through Design

The following summarises the Research Through Design approach that the author took in evaluating each publication in isolation, seeking keywords and themes and then synthesising these findings into a model of praxis described by the publications as an holistic body of knowledge.

Following initial evaluation, each of the publications was reviewed with the author seeking to identify key words, phrases and concepts pertinent to the development of new knowledge, and meaning, at the intersection of disciplinary boundaries. These were identified and then, through keyword and pattern identification grouped thematically for each publication. The exercise was repeated for each publication (Figure A4i shows one example of this).

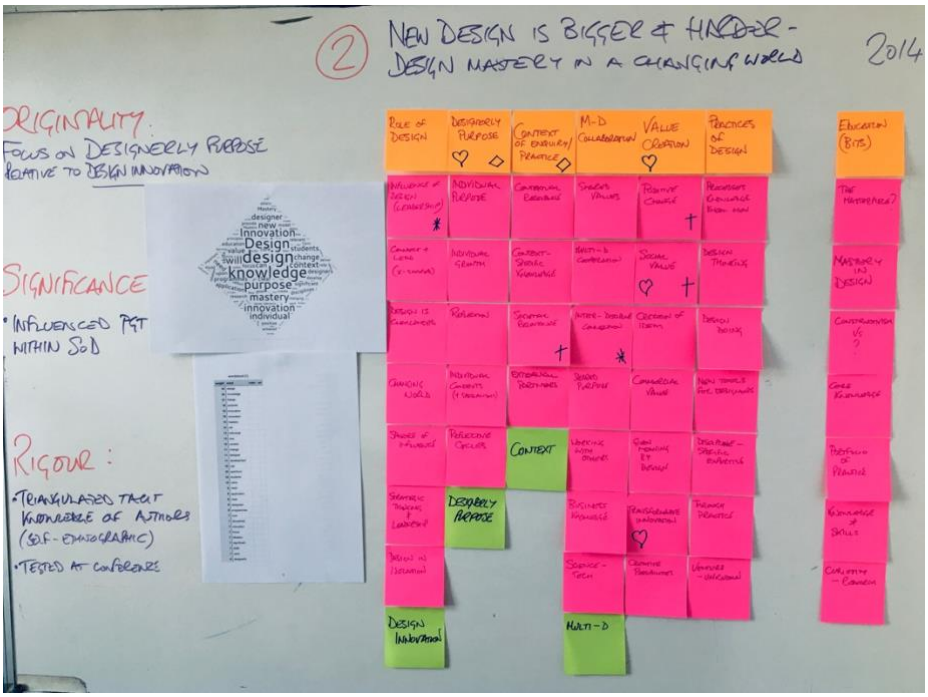

Figure A4i. Example of thematic grouping

Recognising the importance of allowing ideas and theories to emerge concurrently, the author, as this analysis was progressing, allowed the emerging themes to inform idea generation (Figure A4ii) in order to sketch out what the data was telling him about the practice and, in turn, allowing him to reflect upon the emerging themes and their relationship.

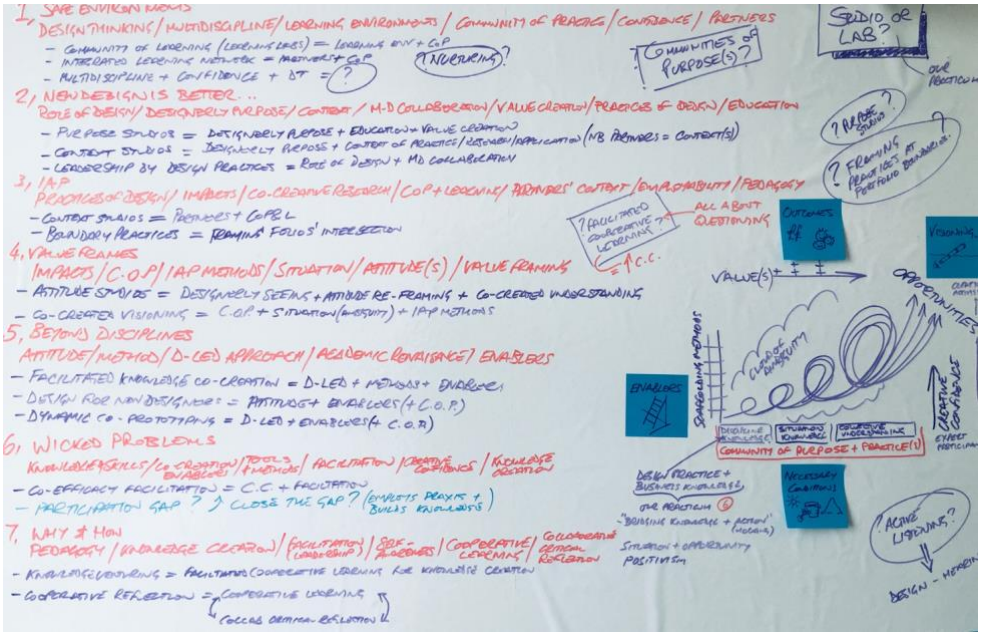

Figure A4ii. Emerging theories and concepts

The key themes, based on their importance to the evolving understanding of praxis, that emerged from analysis of each paper were subsequently synthesised and clustered to establish an understanding of the overall themes represented within the body of knowledge (Figure A4iii)

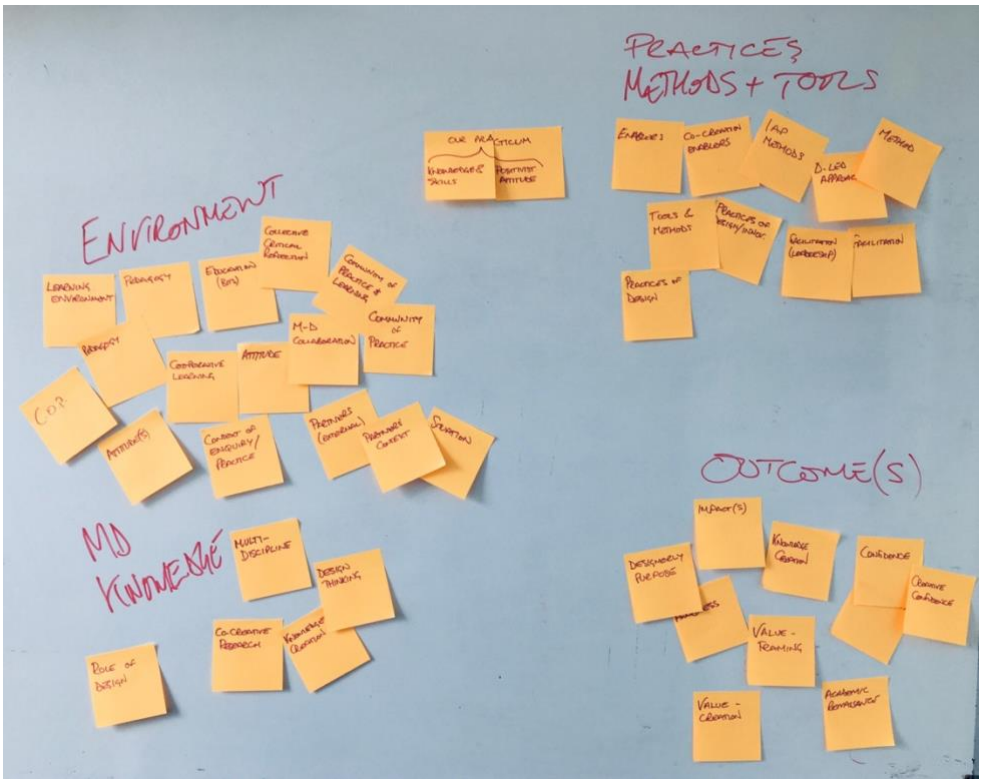

Figure A4iii. Synthesised thematic clusters

The author sought to separate outcomes and impacts and in so doing arrived at three key and distinct elements essential to practice which have been characterised as Actions, Attitudes and Actors (Table A4i).

Practice Elements	Characteristics of element identified in publication
ACTIONS: Practices, methods & tools (Predominantly design-led and comprising existing, adapted, hybrid and new)	Existing (within disciplines) 5, 6 Experimental 6, 4
ATTITUDES: Environmental factors influencing behaviour (constituted of physical space, pedagogic practices, positive attitude, project contexts and situations)	'Safe' and nurturing 1, 2, 5, 7 Research focused 3, 4
ACTORS: (multi-) Disciplinary upbringing (Formal and informal learning (knowledge, skills and attitude) particular to a given discipline)	Extant knowledge, skills, attitude 1, 2 Speculative knowledge, skills, attitude 5, 7

Table A4i. Emergent key thematic elements

The act of thematic clustering was a form of constructive analysis of the publications through which the author was able to synthesise his developing understanding into a descriptive model of practice. Starting with an initial sketch (Figure A4iv) the author triangulated his emerging conceptual model with relevant literature and his tacit knowledge of the practice under review.

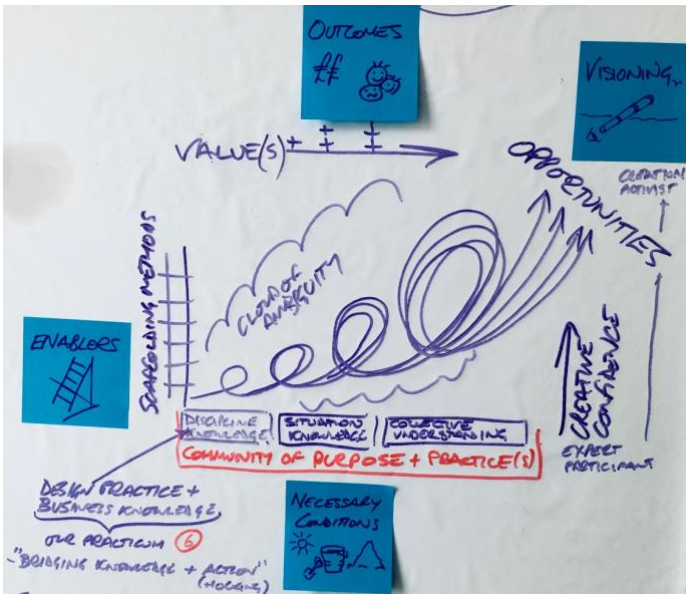

Figure A4iv. Initial sketch visualisation of community of practice's praxis

This rough sketch represents the author's initial thoughts about practice, supported by theory, involved in addressing the 'cloud of ambiguity' presented by the individual project being addressed. A series of iterative cycles of idea generation, evaluation and refinement are situated within a framework comprising foundational extant knowledge (represented along the x-axis) and established

methods and tools as scaffolding (up the y-axis). Multiple ideas are explored concurrently and from them multiple opportunities are created.

Subsequent cycles of reflection and refinement (Figure A4v) enabled the author to establish a detailed model of practice which is described in Chapter 6.

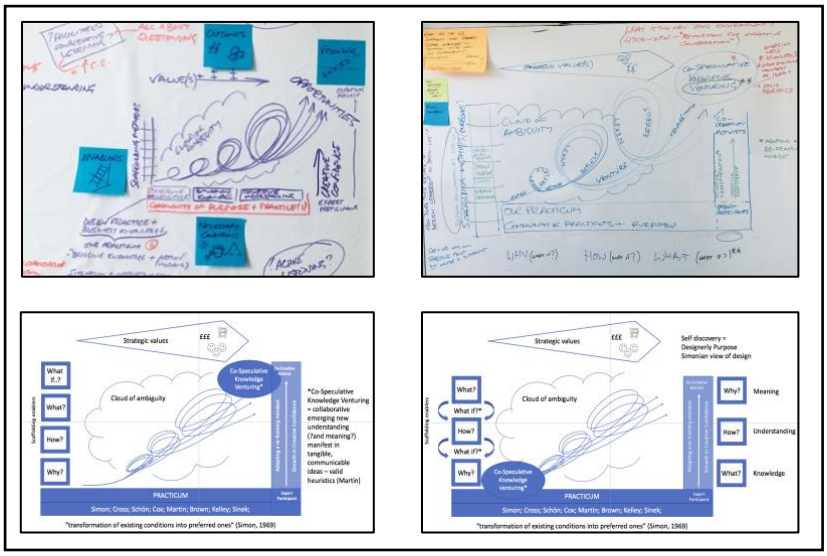

Figure A4v. Iterative development of model of practice

In iteratively modelling praxis, the author initially considered C-SKV as the ‘end’. However, in the final iteration he reconceptualises it as a means by which new knowledge and understanding are created.

APPENDIX 5: Declarations of authorship

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Mark Bailey

Name of co-author: Neil Smith

Full bibliographical details of the publication (*including authors*)**:**

Bailey, M., and Smith, N. (2010) 'Safe Environments for Innovation-Developing a New Multidisciplinary Masters Programme' in Boks, W. et al (eds.) *DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education - When Design Education and Design Research meet ...* Strathclyde: The Design Society Institution of Engineering Designers, pp60–65

Section B

DECLARATION BY CANDIDATE (*delete as appropriate*)

I declare that my contribution to the above publication was as:

(i) principal author

~~**(ii) joint author**~~

~~**(iii) minor contributing author**~~

My specific contribution to the publication was (*maximum 50 words*):

Overall responsibility – 80%
Responsible for conducting pilot studies upon which research is based.
Principal responsibility for analysis and findings/recommendations.
Responsible for write-up.

Signed .....(candidate) 6/11/19 (date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author) **....18.11.2019**.....(date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Mark Bailey

Name of co-author: Trevor Duncan

Full bibliographical details of the publication (*including authors*):

Bailey, M., Duncan, T. and Aftab, M. (2014) 'New Design is Bigger and Harder-Design Mastery in a Changing World' in Bohemia, E. et al (eds.) *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations.* Strathclyde: The Design Society Institution of Engineering Designers, pp. 443–448

Section B

DECLARATION BY CANDIDATE (*delete as appropriate*)

I declare that my contribution to the above publication was as:

(i) principal author

~~**(ii) joint author**~~

~~**(iii) minor contributing author**~~

My specific contribution to the publication was (*maximum 50 words*):

Overall responsibility: 70%
Responsible for creating the the research site and the research environment and community of practice in which this research is undertaken.
Responsible for initiating this study, analysis and write-up.
Jointly responsible for the conceptual model.

Signed: .....(candidate) 6/11/19 (date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

or **(ii)** **I ~~do not agree with the above declaration by the candidate for the following reason(s):~~**

Signed: .....(co-author) 15/11/19 (date)

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Mark Bailey

Name of co-author: Mersha Aftab

Full bibliographical details of the publication (*including authors*):

Bailey, M., Duncan, T. and Aftab, M. (2014) 'New Design is Bigger and Harder -Design Mastery in a Changing World' in Bohemia, E. et al (eds.) *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations*. Strathclyde: The Design Society Institution of Engineering Designers , pp. 443–448

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Jointly responsible for the conceptual model.

Signed: .....(candidate) 6/11/19 (date)

Section C

STATEMENT BY CO-AUTHOR (*delete as appropriate*)

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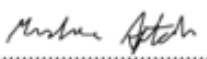
or ~~**(ii)**~~ ~~**I do not agree with the above declaration by the candidate for the following reason(s):**~~



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Mersha Aftab

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

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Section A

Name of candidate: Mark Bailey

Name of co-author: Neil Smith

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

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Section A
Name of candidate: Mark Bailey

Name of co-author: Nicholas Spencer

Full bibliographical details of the publication (*including authors*):

Bailey, M., Spencer, N., Smith, N., Knott, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design-led Innovation Practice' in Marjanović, D. et al (Eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781–1792

Also published in translation as:
Bailey, M., Spencer, N., Smith, N., Aftab, M., Knott, C., nd Sams, P. (2018) Framing Strategic Value por meio de Design-led Innovation Practice. *Project Design Management*, 16 (82). pp. 54-63.

Section B
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I declare that my contribution to the above publication was as:

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(ii) ~~**joint author**~~

(iii) ~~**minor contributing author**~~

My specific contribution to the publication was (*maximum 50 words*):
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Responsible for creating the research site and community of purpose and practice in which this research is undertaken.
Responsible for initiating this study and jointly responsible for the conceptual model.
Responsible for write-up

Signed: .....(candidate) 6/11/19 (date)

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(i) **I agree with the above declaration by the candidate**

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Neil SmithDECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

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Section A
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Name of co-author: Neil Smith

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Bailey, M., Spencer, N., Smith, N., Knott, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design-led Innovation Practice' in Marjanovi–, D. et al (Eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781–1792

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Responsible for write-up

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Neil Smith 

Signed: .....(co-author) 18.11.2019 .....(date)

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DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Christopher Knott

Full bibliographical details of the publication *(including authors):*

Bailey, M., Spencer, N., Smith, N., Knoll, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design-led Innovation Practice' in Marjanovic, D. et al (Eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781-1792

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Section B
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(ii) **jaint authar**

(iii) **miner cantributing authar**

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Responsible for write-up

Signed: .....(candidate) 6/ 11 /19 (date)

Section C
STATEMENT BY CO-AUTHOR *(delete as appropriate)*

Either **(i)** **I agree with the above declaration by the candidateV**

or **'iii.___** **I do not agree with the above declaration by the candidate for the"-/ following reason(s):** /'—

Signed: .....(co-author) 11/11/19 (date)

northumbria
UNIVERSITY NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Mersha Aftab

Full bibliographical details of the publication (*including authors*):

Bailey, M., Spencer, N., Smith, N., Knott, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design -led Innovation Practice' in Marjanović, D. et al (Eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781–1792

Also published in translation as:
Bailey, M., Spencer, N., Smith, N., Aftab, M., Knott, C., nd Sams, P. (2018) Framing Strategic Value por meio de Design -led Innovation Pra ctice. *Project Design Management* , 16 (82). pp. 54-63.

Section B
DECLARATION BY CANDIDATE (*delete as appropriate*)

I declare that my contribution to the above publication was as:

(i) principal author

(ii) ~~joint author~~

(iii) ~~minor contributing author~~

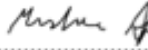
My specific contribution to the publication was (*maximum 50 words*):
Overall responsibility – 70%
Responsible for creating the research site and community of purpose and practice in which this research is undertaken.
Responsible for initiating this study and jointly responsible for the conceptual model .
Responsible for write -up

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

or



Signed: .....(co-author) 7/11/2019 (date)

Mersha Aftab

northumbria
UNIVERSITY NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Phil Sams

Full bibliographical details of the publication (*including authors*):

Bailey, M., Spencer, N., Smith, N., Knott, C., Aftab, M. and Sams, P. (2018) 'Framing Strategic Value through Design-led Innovation Practice' in Marjanovic, D. et al (Eds.) DS92: Proceedings of the DESIGN 2018 15th International Design Conference. Glasgow: The Design Society, pp. 1781–1792

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Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

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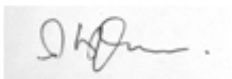

Signed electronically: PHIL SAMS.....(co-author).....**07/11/2019.**.....(date)

UNIVERSITY NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Katarzyna Dziewanowska

Full bibliographical details of the publication (*including authors*)**:**

Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018).* Loughborough: DRS, pp. 538–545

Section B
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Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author) 08.11.2019 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Brian Harney

Full bibliographical details of the publication (*including authors*):

Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018)*. Loughborough: DRS, pp. 538–545

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Responsible for write-up

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author)..... **7th of Novemmber 2019** (date)
Brian Harney, Associate Professor, Dublin City University Business School
brian.harney@dcu.ie

UNIVERSITY NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Katja Mihelic

Full bibliographical details of the publication (*including authors*)**:**

Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018).* Loughborough: DRS, pp. 538–545

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Section C
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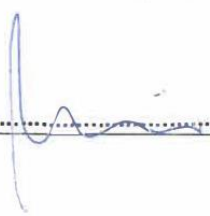

Signed: .....(co-author) 8/11/19 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Alison Pearce

Full bibliographical details of the publication (*including authors*):

Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018)*. Loughborough: DRS, pp. 538–545

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Responsible for write-up

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author) **....11/11/19**.....(date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Nick Spencer

Full bibliographical details of the publication (*including authors*):

Bailey, M., Dziewanowska, K., Harney, B., Mihelic, K., Pearce, A. and Spencer, N. (2018) 'Beyond Disciplines: can design approaches be used to develop education for jobs that don't yet exist?' in Bohemia, E. et al (eds.) *DS 93: Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018)*. Loughborough: DRS, pp. 538–545

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Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

(i) I agree with the above declaration by the candidate

Signed: ....  .....(co-author) 14.11.19 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Emmanouil Chatzakis

Full bibliographical details of the publication (*including authors*):

Bailey, M., Chatzakis, E., Spencer, N., Lamoitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127, doi: 10.1386/dbs.5.1.95_1

Section B
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(ii) ~~joint author~~

(iii) ~~minor contributing author~~

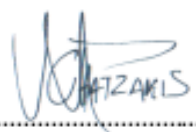
My specific contribution to the publication was (*maximum 50 words*):

Overall responsibility 70%
Principle Investigator responsible for the study design and execution.
Responsible for the team involved in delivering the generative research workshops, conducting the research and analysis.
Jointly responsible for development of theoretical model.
Responsible for the overall write-up.

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**



Signed: .....(co-author) 07.11.2019 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Nicholas Spencer

Full bibliographical details of the publication (*including authors*):

Bailey, M., Chatzakis, E., Spencer, N., Lampitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127, doi: 10.1386/dbs.5.1.95_1

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Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

(i) I agree with the above declaration by the candidate

Signed: ....  .....(co-author) 14.11.19 (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Kate Lampitt Adey

Full bibliographical details of the publication (*including authors*)**:**

Bailey, M., Chatzakis, E., Spencer, N., Lampitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127, doi: 10.1386/dbs.5.1.95_1

Section B
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Jointly responsible for development of theoretical model.
Responsible for the overall write-up.

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

or **(ii) ~~I do not agree with the above declaration by the candidate for the following reason(s):~~**

Signed: K Lampitt Adey (co-author) **.....13/11/19** (date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Nate Sterling

Full bibliographical details of the publication (*including authors*)**:**

Bailey, M., Chatzakis, E., Spencer, N., Lampitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127, doi: 10.1386/dbs.5.1.95_1

Section B
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Responsible for the overall write-up.

Signed: .....(candidate) 6/11/19 (date)

Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

or **(ii) ~~I do not agree with the above declaration by the candidate for the following reason(s)~~:**

Signed: .....(co-author) 13/11/19 (date)

northumbria UNIVERSITY NEWCASTLE

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A
Name of candidate: Mark Bailey

Name of co-author: Neil Smith

Full bibliographical details of the publication (*including authors*):

Bailey, M., Chatzakis, E., Spencer, N., Lampitt Adey, K., Sterling, N. and Smith, N. (2019), 'A design-led approach to transforming wicked problems into design situations and opportunities', *Journal of Design, Business & Society*, 5:1, pp. 95–127, doi: 10.1386/dbs.5.1.95_1

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Section C
STATEMENT BY CO-AUTHOR (*delete as appropriate*)

Either **(i) I agree with the above declaration by the candidate**

Signed: .....(co-author) **....18.11.2019**.....(date)

DECLARATION OF CO-AUTHORSHIP OF PUBLISHED WORK

(Please use one form per co-author per publication)

Section A

Name of candidate: Mark Bailey

Name of co-author: Nicholas Spencer

Full bibliographical details of the publication (*including authors*):

Bailey, M. and Spencer, N., 2019. The Why and How of Design-led Multidisciplinary Innovation Education: Context and Curriculum. The International Journal of Design Education.
13 (4): 89-109. doi:10.18848/2325-128X/CGP/v13i04/89-109.

Section B

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Responsible for creating the research site and the pedagogic principles that underpin the site.
Responsible for establishing the community of practice in which, and about which, this research is undertaken.
Jointly responsible for research and analysis.
Responsible for the overall write-up.

Signed.....(candidate) 6/11/19 (date)

Section C

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